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A PETITION is to be presented to Congress this month, signed by a large number of ship-owners and others in all the lake cities, asking for increased appropriations for the purpose of maintaining lights of a permanent character on the lakes, and a greater number of lighthouses seem to be much needed, and also an increase in the number of light-ships and beacons. The increase of commerce in the last few years has been so large, and the number of vessels now employed and the value of their freight is so great that more attention to this point is really warranted, and it is to be hoped that the petition will be effectual. A government survey and wrecking vessel is also much needed, and should be provided.

THE lake shipping interests are preparing to urge upon Congress a continuation of the work to be done upon the channels at various points, for the purpose of maintaining at least 21 ft. depth of water from Buffalo to the upper end of Lake Superior. The amount of work to be done to form and maintain such a channel is very large, and it is a question whether the attempt will be wholly successful. The lake shipping interests are very large, but if more attention were paid to the designing of ships to carry a heavy load on a small draft, the 21-ft. channel might be unnecessary.

THE monument at Bordentown, which is elsewhere described, is worthy of imitation, not only because it is in itself very simple, tasteful and appropriate, but also because such memorials should be increased in number. It is an excellent practice to preserve the memory of historical events by monuments, and the railroad history is fully as important in its way as the political and warlike history of the nation. Much credit is due to Mr. Watkins for suggesting the Bordentown monument, and to the officers of the Pennsylvania Railroad Company for the way in which the suggestion has been carried out.

THE death of Mr. Moncure Robinson at the advanced age of 90 years removes the last of the older generation of engineers. Mr. Robinson was a contemporary of Benjamin H. Latrobe, John Stevens, William Cook, Ashbel Welch and the other engineers who laid the foundations of our railroad system and gave form and direction to its development. He was one of the few who foresaw the future of the railroad, for he was an early advocate of it in preference to the canal; and it is said that when he located the Philadelphia & Reading Railroad, his colleagues were confounded by the extent of the provision he thought necessary for terminals.

Mr. Robinson retired from the active work of his profession so long ago that he was little known to the present generation of engineers; but he was often called in consultation, and was noted for his kindness to younger men and his willingness to give advice.

THE lake which was formed during the present year at Salton in the Colorado Desert by water overflowing from the Colorado River is now, it appears, gradually decreasing in size by evaporation, and it is said that the current of water which fed it and caused its formation has been cut off. In that case it will be only a short time before it disappears, on account of the extremely rapid evaporation prevailing in that part of country.

THE supply of copies of the RAILROAD AND ENGINEERING JOURNAL for June, 1888, is entirely exhausted. As we need a few, any subscriber who may have a copy of that date, and who does not preserve his files, will confer a favor upon the JOURNAL by sending it to the office. For any copy of that issue sent in, the sender will receive a credit of *two months* on his current subscription.

ENGLISH AND AMERICAN LOCOMOTIVES.

II.

LOADS HAULED.

IN our article on this subject published last month, brief reference was made to the consumption of coal by British and by American engines. Of course, in any comparison of fuel consumption account should be taken of the loads hauled. Unfortunately only a few of our American railroad companies—and, so far as

TABLE V. SHOWING THE AVERAGE NUMBER OF PASSENGER AND FREIGHT CARS HAULED, THEIR WEIGHT, AND FUEL CONSUMED PER MILE, AND PER TON PER MILE.

1	PASSENGER TRAINS.				FREIGHT TRAINS.			
NAME OF ROAD.	2 Av. No. of Cars per Train.	3 Weight of Train, exclusive of Engine and Tender.	4 Lbs. of Coal Consumed per Mile.	5 Lbs. of Coal Consumed per Ton of Cars.	6 Average No. of Cars per Train.	7 Weight of Train, exclusive of Engine and Tender.	8 Lbs. of Coal Consumed per Engine, Mile.	9 Lbs. of Coal Consumed per Ton of Cars.
	No.	Tons of 2,240 lbs.	lbs.	lbs.	No.	Tons of 2240 lbs.	lbs.	lbs.
Chesapeake and Ohio	4.52	123.2	63.65	.516	18.9	472.5	127.4	.248
Chicago and Alton	5.20	139.7	72.3	.517	20 32	508.0	96.1	.189
Cincinnati Southern	4.3	117.9	55.0	.466	22.8	570.0	98.0	.172
Cleveland, Cincinnati, Chicago and St. Louis	4.5	122.8	63.21	.514	21.4	535.0	106.7	.197
Illinois Central	4.49	122.4	74.9	.612	15.36	384 0	108.4	.282
Louisville and Nashville	5.11	137.4	60.5	.440	13.11	327.7	93.3	.284
Michigan Central	5.5	147.0	72.71	.494	32.0	800.0	128.0	.160
New York, Lake Erie and Western	4.9	132.4	85.0	.641	21.8	545.0	122.4	.224
New York, Pennsylvania and Ohio	5.1	137.2	70.0	.511	19.1	477.5	117.9	.247
Pennsylvania (Philadelphia to Pittsburgh)	4.95	133.6	67.5	.505	24.37	609.25	136.0	.223
" (Lines West of ")	5.33	142.8	58.87	.412	23.87	596.75	100.3	.168
Philadelphia and Erie	3.84	106.9	60.0	.552	32.66	816.5	153.8	.188
Averages*	4.81	130.3	66.97	.515	22.14	553.5	115.7	.215

* These are the averages of the averages of each road.

we know, none of the British lines—publish any statistics which show what their train loads are. Table II, published last month, shows that some of the companies whose reports have been tabulated therein do report the average number of cars, of both passenger and freight trains, and the average consumption of coal per mile for both. These figures have, for convenience of comparison, been condensed in Table V, in which the name of the road is given in the first column, and the average number of passenger and freight cars per train in the second and sixth, and the pounds of coal consumed per engine mile for each class of trains in the fourth and eighth.

To determine the weight of the average train, all that can be done will be to make an approximation; but this may be sufficiently close to the actual weight, so that the difference will not be sufficient to affect materially the deductions therefrom.

The average passenger train, it may be assumed, consists of a baggage, a mail, or an express car, whose weight loaded will be about 60,000 lbs.; a dining, drawing-room, or sleeping car, whose loaded weight will be about 80,000 lbs., and the balance of the train will consist of ordinary passenger cars or coaches, whose weight with the passengers will be about 54,000 lbs. each. If, then, it is assumed that each train consists of one baggage car, one sleeper, and the rest ordinary passenger cars, the approximation to the actual weight will be sufficiently near to enable us to draw deductions therefrom. The weight of the average passenger trains, contained in Table V, has been calculated in this way, and is given in tons of 2,240 lbs. in the third column. By dividing this weight into the pounds of coal consumed per mile shows the quantity of coal consumed per ton of cars per mile. This is given in column 5. From this it will be seen that the average consumption of coal for passenger train is almost exactly one-half a pound per ton per mile.

In the sixth column of the table the average number of freight cars per train for the different roads is given. It may be said that this number is reduced to loaded cars, two empties being generally rated as one loaded, or in some cases five empties are rated as three loads. To determine the weight of these cars, we must again resort to a process of deduction. We have before us the report of some experiments made on the Illinois Central Railroad in 1889, which gives the weights of empty cars as follows:

100	Box cars.
71	Coal "
5	Refrigerator cars.
5	Flat or platform cars.
1	Fruit car.
6	Tank cars.
5	Caboose "
5	Passenger "
2	Stock "
45	Class unknown "
Total 245	

of which the aggregate weight was 5,767,895 lbs., or an average of 23,542 lbs. each. These cars composed the average trains of the traffic on the road named. To confirm this, the following weights are given of different classes of freight cars on the Pennsylvania Railroad:

Box car	20,300 lbs.
" "	24,900 "
" "	27,800 "
" "	29,600 "
Flat or platform cars	19,900 "
" " "	22,100 "
Gondola "	23,100 "
Hopper gondola "	20,700 "
" " "	23,200 "
Drop bottom "	26,400 "
" " "	29,300 "
" " gondola cars	18,500 "
Stock or cattle "	19,000 "
" " " "	26,200 "
Dead hog "	27,200 "
Refrigerator "	38,300 "
Charcoal "	28,600 "
Total	425,100 "
Average	25,006 "

It is probable that the cars of the Pennsylvania road are

somewhat heavier than the average through the country. Besides, the proportion of the lighter cars, such as flat or platform and cattle cars, in ordinary trains is greater than of the heavier class, like refrigerator and heavy box cars. For this reason we will take the average weight of the cars on the Illinois Central trains, and assume that an average loaded freight car weighs 23,000 lbs.

In the report referred to the weight of the loads of 214 cars is also given, and amounts to 7,927,819 lbs., or an average of 37,046 lbs. In the last annual report of the Pennsylvania Railroad Company the average car load for the year is given at 16.79 tons (of 2,000 lbs.) = 33,580 lbs. Therefore, if we assume the average car load to be equal to 33,000 lbs., we are quite certain that the assumption is not higher than the actual weight. By adding this average load to the weight of the empty car = 23,000 lbs. gives us 56,000 lbs. = 25 tons of 2,240 lbs. as the average weight of loaded freight cars, which is surely a very close approximation to the actual weight under the ordinary conditions of traffic in this country. With these figures, the weight of the average freight trains given in Table V has been calculated, and will be found in column 7. Dividing this into the pounds of coal consumed per freight engine mile, gives, as in the case of passenger trains, the coal consumed per ton of cars per mile. The average for the twelve roads given in the table is .215 lbs. per ton per mile.

Owing to the fact that the weight of trains on British roads is not reported, or even recorded, it is impossible to make any comparisons of the relative fuel consumption per ton per mile in the two countries from the figures given in our tables. In the one relating to English locomotives, published last month, it will be seen that the fuel consumption is not even given separately for passenger and freight trains, and, so far as we know, no data are obtainable concerning the average weights of either class of trains.

In a recent English book on the railway rates question,* the author, who seems to be thoroughly familiar with the subject, in referring to the low rates at which freight is carried in this country, says: "No accurate comparison with these figures is possible in the case of the English railways, because the necessary statistics are not in existence. We know that in round figures 300,000,000 tons were carried at a cost of £40,000,000 sterling—at an average cost, that is, of 2*s*. 8*d*. per ton. Supposing the average distance traveled to have been 20 miles, this would be roughly equivalent to 1½*d*. per ton mile; or, supposing the distance to have been 32 miles, it would be equivalent to one penny. Probably the truth is that the distance was nearer the shorter than the longer figure. *If we say that English traffic paid on an average 1½d. per ton per mile, our guess will probably be as near the truth as it is possible to go.* The 50 or 60 per cent. reduction which the American railways have achieved is therefore, without doubt, a feat of which they have every right to be proud."

Taking Mr. Ackworth's guess—and it is that of a man apparently thoroughly acquainted with the subject—as representing the nearest approximation possible to the average British rates, and then taking the average traffic receipts for goods trains per mile, contained in Table I, and dividing the one by the other, and we have an average train load of only 56.6 tons. If the weight of the "wagons" is equal to the paying load, the total weight of train would be 113.2 tons; if the dead weight of cars is twice the load, the total weight of train would be 169.8, or, say, 170 tons.

This latter weight is less than a third as much as the average weight of freight trains on the twelve American roads given in Table V. Of course it is impossible to draw any quantitative conclusion from such imperfect data, but they indicate very distinctly why the consumption of fuel by American freight engines per train mile is greater than that of the same class of English locomotives.

Happily *The Engineer* has given us some more specific data concerning the performance of English freight engines. In its issue of November 7, of last year, a tabular statement was published in which the performance of new goods engines was reported on different gradients on the North British Railway, between Glasgow and Carlisle in the winter of 1876–77. The trial was carried out by Mr. Drummond, then the locomotive superintendent of that line, in order to test the relative merits of the injector and the feed-pumps as boiler feeders. Table VI is a reprint of *The Engineer's* report of this test. It will be seen that in the tenth column of this table the fuel consumption is reduced to the quantity burned per mile per ton of train or cars. The average for the 16 trials was .272 lbs. per ton per mile. This, it will be observed, was during a trial, to which special attention is always attracted, and therefore better results are attained than in ordinary practice. On the other hand, the figures given in Table V are the results of a whole year's working on 12 different roads in this country. It will be seen that the average consumption with freight trains on the 12 American roads was only .215 lbs. per ton of train per mile, whereas on the North British road it was .272, a performance which the Editor of *The Engineer* seems to think represents at least good, if not the best performance of an English freight engine.

We are able, however, to compare this test on the North British road with a similar one on the New York Central road, which was made last year under the supervision of Mr. Buchanan, the Superintendent of Machinery of that line. As the weight of the trains is given in the report of the North British tests, and also in that of Mr. Buchanan's experiments, it is possible to compare the consumption of fuel per ton mile on each road.

The trial on the New York Central road consisted of nine round trips between Buffalo and Dewitt, a distance of 150 miles, so that the whole distance run during the tests was 2,700 miles. The engine was of the mogul type and weighed in working order 120,000 lbs. = 53.5 tons (of 2,240 lbs.). The weight on driving-wheels was 104,500 lbs. = 46.6 tons. The driving-wheels were 64 in. in diameter, the cylinders 19 × 26 in. The average speed of trains was 15.8 miles per hour. The steepest grade eastward was 34 ft. per mile; westward it was 42 ft. In order to compare the New York Central trials with those on the Scotch road, under as nearly the same conditions as possible, we have selected, for comparison, from the latter the six runs which were made "up ruling gradients of 1 in 100" = 52.8 ft. per mile, and "up and down ruling gradients of 1 in 900" = 5.8 per mile, and have tabulated the average results of these and the New York Central trials in Table VII.

The average train load in the New York Central test (col-

* "The Railways and the Traders; or, Sketch of the Railway Rates Question in Theory and Practice," by W. M. Ackworth.

TABLE VI. NORTH BRITISH RAILWAY. PERFORMANCE OF NEW GOODS ENGINES ON DIFFERENT GRADIENTS BETWEEN GLASGOW AND CARLISLE. WINTER OF 1876–77.

Engine No. 281, pumps, exhaust-cocks under foot-plate, feed-water supplied to boiler at average temperature of 127°. Consumption of coal from monthly sheets.

Engine No. 305, pumps, exhaust-cocks under cylinders, feed-water supplied to boiler at average temperature of 107¾. Coal specially measured.

Engine No. 292, injectors, consumption of coal specially measured.

All three engines are of the same class, 18 in. × 26 in. cylinders, and 5-ft. wheel-cylinder power 140.4; adhesive weight, 39½ tons. No. 281 evaporates 8.95 lbs. of water per lb. of coal; No. 305 evaporates 8.24 lbs.; and No. 292 evaporates 8.21 lbs.

Gradients.		3	4	5	6	Average Weight.		Coal.		
1 Average.	2 Maximum.	Ruling Gradients.	No. of Engine.	Average Speed whilst in Motion.	Average Distance between Stops—Traffic, Water and Signals.	7 Train—Van, Wagons and Load.	8 Engine and Train.	9 Per Train Mile.	10 Per Mile, per Ton of Train.	11 Per Mile, per Ton of Engine and Train.
				Miles per hour.	*Miles.*	*Tons.*	*Tons.*	*Lbs.*	*Lbs.*	*Lbs.*
1 in 85	1 in 70	Up ruling Gradients of 1 in 70.	281	13.20	12.44	290.0	356.0	95 00	0.327	0.267‡
1 in 84	1 in 75		305	16.20	8.34	229.0	295.0	98.51	0.430	0.334‡
.....	1 in 70		305	11.40	10.00	211.5	279.0	131.06	0.619	0.470§
1 in 92	1 in 70		292	13.10	13.60	233.0	300.0	106.04	0.454	0.354‡
1 in 260	1 in 100	Up ruling Gradients of 1 in 100.	281	17.20	10.04	268.0	334.0	68.00	0.254	0.204
1 in 333	1 in 100		305	20.95	8.20	194.3	260.0	70.58	0.363	0.271
1 in 351	1 in 100		392	19.40	10.97	220.8	287.0	68.53	0.310	0.239
Level	1 in 900	Up and down ruling Gradients of 1 in 900, or practically level.	281	18.96	10.10	247.5	314.0	46.10	0.186	0.147
Level	1 in 900		305	21.80	7.00	247.4	314.0	52.62	0.213	0.168
Level	1 in 900		292	24.12	7.94	222.0	288.0	50.16	0.226	0.178
1 in 220	1 in 75	Down.	281	21.00	7.40	302.0	368.0	30.50	0.100	0.083
1 in 205	1 in 75		305	24.30	31.00	275.5	341.8	31.18	0.113	0.091
1 in 528	1 in 75		292	28.80	31.40	211.9	278.0	25.60	0.121	0.092
Averages of about 1,000 miles, with each engine running similar goods trains between Glasgow and Carlisle, *via* Waverley route.			281	18.40	8.78	267.0	333.0	49.50	0.185	0.149
			305*	19.80	8.23	244.6	311.0	56.39	0.230	0.182
			292†	20.50	8.88	230.6	297.0	53.36	0.231	0.180
General Averages.....			...	...	.....	247.4	...	64.56	0.272	.....

* Number of wagons—loaded, 30.95; empty, 5.40; total, 36.35; equivalent number of loaded wagons, 34.55.

† Number of wagons—loaded, 26.66; empty, 9.53; total, 36.19; equivalent number of loaded wagons, 33 02.

‡ Assisted by pilot. § Without pilot.

umn 6) was 1,212 tons, in the North British 233.3. The weight of train hauled in the former test was 22.6 times the weight of the engine; in the latter it was only six times. The total weight of the English engine was not given, but it is said that the adhesive weight was 39½ tons. As the ordinary type of goods locomotive on British roads is a six-wheeled engine, all the wheels being drivers and all coupled, it is inferred that this was the type of engine used, and that the adhesive weight was also the total weight.

The distances run, the average speed while in motion, the ruling grade, the average number of cars hauled and their aggregate weight, the total weight of engines and weight on driving-wheels are given. The proportion of the weight of locomotive to that of the cars hauled has been calculated, the pounds of coal consumed per mile run, and per ton per mile are all given. The coal consumed per mile (column 10) by the North British engine was 59.3 lbs., while Mr. Buchanan's machine burned 127.7 lbs., or more than twice as much as the other. But if we compare the amount of fuel burned per ton of train per mile (column 11), the proportions are reversed, as the Scotch engine burned .254 lbs., while the American consumed only .105 lbs. per ton per mile. Comment is unnecessary.

It may be said, however, and very properly, too, that in railway traffic there are always two kinds of trains: one, the loads of which are limited by the number of passengers or freight to be carried, and another, the weight of which is limited only by the capacity of the engine. Thus on coal roads, and on most of our through lines, there is an unlimited amount of freight to be transported, whereas on lines doing a local freight or passenger business the number of people and the tonnage to be carried does not exceed a certain number or amount. The cost of the former traffic should be estimated at its cost per ton per mile, the latter in terms of the cost per train mile. We will take up the total cost of motive power per ton of train first.

To do this the subject of

REPAIRS

must be considered. During the discussion, of which this article is a part, the Editor of *The Engineer* has complained that he has invariably failed to obtain any trustworthy information concerning the cost of repairs in the United States. We have, therefore, been at considerable pains to collect information with reference to this point, which is given in Table II, published last month. It will be seen from column 11 of that table that the average cost of repairs on the 41 roads included in the table was 4.25 *cents per mile run*. The average cost on the British roads, included in Table I, was 5.3 *cents*. The difference appears the more remarkable when the fact that our engines haul much heavier trains is taken into consideration, and that the cost of labor and material are both higher here than it is in England, Scot-

TABLE VII. SHOWING THE COMPARATIVE RESULTS OF TESTS OF FREIGHT LOCOMOTIVES ON THE NORTH BRITISH AND THE NEW YORK CENTRAL RAILROADS.

NAME OF ROAD.	2 Distance Run.	3 Average Speed while in Motion.	4 Ruling Grades.	5 Average Number of Loaded Cars in Train.	6 Weight of Cars in Train, with their Loads.	7 Total Weight of Locomotive.	8 Weight on Driving-Wheels of Locomotive.	9 Proportion of Weight of Locomotive to Weight of Train.	10 Lbs. of Coal Consumed per Mile Run.	11 Lbs. of Coal Consumed per Ton of Train (Exclusive of Engine and Tender) per Mile.	12 Value of Coal Consumed per Mile at 1 Mill per Lb.	13 Cost of Repairs of Engine per Mile.	14 Cost of Oil, Waste, and Supplies per Mile.	15 Wages of Enginemen, Firemen, and Cost of Cleaning and Attendance per Mile.	16 Total Cost of Locomotive Service per Engine Mile.	17 Total Cost of Locomotive Service per Ton of Train (Exclusive of Engine and Tender) per mile.	18 Cost of Conductors and Brakemen per Mile.	19 Total Cost of Locomotive and Train Service per Mile.	20 Cost of Locomotive and Train Service per Ton of Train (Exclusive of Engine and Tender) per mile.
	Miles.	Miles per Hour.	Feet per Mile.	No.	Tons of 2,240 lbs.	Tons of 2,240 lbs.	Tons of 2,240 lbs.		Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
North British.....	3,000	20.4	6 and 52	.....	233.3	39.5	39.5	1 to 6	59.33	.254	5.93	3.06	.....	8.64	17.63	.075	4.8	22.43	.096
New York Central...	2,700	15.8	34 and 42	48.67	1212.0	53.57	46.65	1 to 22.6	127.70	.105	12.77	2.61	.33	6.25	21.96	.018	6.2	28.16	.023

land, and Ireland. More than a year ago our adversary took occasion to remark, that "it is very difficult to understand how, seeing that labor and materials are all more expensive on the other side of the Atlantic than here, the work of repair can be done for less money." We can't explain why our cotemporary has difficulty in understanding the undoubted fact, which is shown by the figures in our table, but it is a fact, nevertheless, and it is due to the better designs of our engines, which have been made or evolved more with reference to facility of repair than English locomotive designs have been. We hoped to be able to show wherein our plans and methods of construction are better than those of our cousins, and the reasons for the diminished cost of repairs, by comparing the drawings of the different parts of a typical English and American locomotive; but our cotemporary declined to accede to our proposition to publish complete engravings of one of their engines, on condition that we should publish similar engravings of one of our locomotives.

It does not seem necessary to emphasize the advantages which American locomotives have from their greater facility of repair. As a consequence in great part of this their average mileage is nearly 50 per cent. greater than that of English engines, while at the same time the cost of repairs here per mile run is 1.05 cents less than that of the latter.

If the cost of repairs on the American roads enumerated in Table II had been as great as it is on British lines, the total extra cost would have been nearly *five and a half millions of dollars*. Our table includes less than half the locomotives and mileage of the country, so that if all our roads were equipped with English engines it would involve an *extra annual expenditure in this country of over* $10,000,000. Nor is this all. As our engines are hauling heavier trains than English engines are, if the cost of repairs of American engines was estimated in proportion to the work done, it would be relatively still less than that of British engines, and the increased cost if the latter were used would be much greater than the above enormous sum.

Next month we will give some data and make some comparisons of the total cost of locomotive service in this country and in England.

(TO BE CONTINUED.)

THE RECENT ARMOR TESTS.

SINCE our last issue a noteworthy trial of armor plate has been going on at the Naval Ordnance Proving Ground at Indian Head, Md.—noteworthy not only on account of the results obtained, but also from the fact that it is the first trial, under modern conditions, of American-made armor, and that it will determine for some time to come the character of the plate to be supplied to our new navy.

It will be remembered that at the Annapolis trial of last September between an English compound and the French steel plates, the victory of the nickel-steel seemed so pronounced that a large appropriation was secured from Congress for the purchase of this metal. But it was felt that no hasty decision should be made, and that a single trial was hardly sufficient to determine just how far the presence of nickel improved the resisting power of a steel plate.

In the tests under consideration three questions are to be settled: 1. Whether or not the plates should contain nickel; 2. Whether they should be of moderately high or of mild steel, and 3. Whether face-hardened or homogeneous throughout. The first trial was had on October 31, the competing firms being the Bethlehem Iron Company and Carnegie, Phipps & Company, of Pittsburgh. Three plates were submitted for test: by the former firm, one of low carbon, all steel, face-hardened by the Harvey process, and a second of untreated high carbon nickel-steel; the Pittsburgh firm came forward with an untreated low-carbon nickel-steel plate. It should be stated that the Bethlehem plates are hammered; those from Pittsburg are rolled. Generally speaking, the low-carbon plate contains from 0.20 to 0.25 of 1 per cent. of carbon; the high carbon from 0.30 to 0.40 of 1 per cent.

The plates were all of the uniform size of 6 ft. × 8 ft. × 10½ in., backed by 3 ft. of oak, thoroughly braced, and supported by a bank of well-rammed earth, and mounted upon the arc of a circle 30 ft. from the muzzle of

the gun. The test was to be four 6-in. shot delivered at the four corners of a square 2 ft. from the edge, and an 8-in. shot in the center of the plate. The 6-in projectiles were 100-lb. armor-piercing Holtzer shell fired from the new 40-caliber rifle, with a muzzle velocity of 2,075 foot-seconds, the charge being 42 lbs. brown powder. The 8-in. projectiles were 210-lb. armor-piercing Firminy shell, having a velocity of 1,850 foot-seconds, the charge being 74½ lbs. of brown powder.

After the four rounds per plate from the 6-in. gun neither of the nickel-steel plates showed a crack, while the all-steel had developed several very serious fissures. The final 8-in. shot started cracks in both the nickel plates —in the high-carbon rather more than in the low-carbon plates—while the all-steel plate was in a very demoralized condition, and may be said to have been put out of the fight. Of the two nickel plates, the high carbon Bethlehem had thrown back every one of the five projectiles, the penetrations being from 9 to 16½ in. The low-carbon Pittsburgh plate had admitted of a penetration almost double that of its rival, four out of the five projectiles being so deeply imbedded in the metal that they, in all probability, would have burst in-board had they been loaded, the penetrations being from 13½ to 29½ in.

Fig. 2.

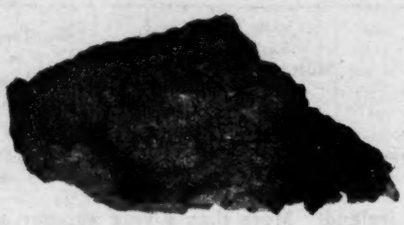


Fig. 1.

The second trial took place on November 15. The plates submitted were a high-carbon untreated and a low-carbon Harvey-treated nickel-steel from Carnegie, Phipps & Company, and a high-carbon, Harvey-treated nickel-steel from the Bethlehem Works. The conditions were practically the same as on the previous trial, except that with the 8-in. gun Carpenter projectiles were used against the two Carnegie plates, and an English Firminy against the Bethlehem plate—an undoubted advantage to the former. The Carnegie high-carbon untreated plate threw back the five projectiles, but admitted penetrations of from 9⅜ in. to 12½ in. Cracking began at the end of the fourth shot on this plate, which the last round increased to a dangerous degree. The low-carbon Harvey-treated plate of this firm behaved in much the same manner as its low-carbon plate at the previous trial, only its ability to resist penetration had been increased in a marked degree, accompanied, however, by a greater disposition to crack. The penetrations were from 9¾ in. to 20¼ in. Three projectiles remained imbedded in the plate. The last shot cracked this plate badly in both directions from the center. The Bethlehem high-carbon hardened nickel-plate was, at the end of the fourth round, practically uninjured. On the left side of the plate the projectiles had penetrated about 12 in. and rebounded; on the right side what appeared to be blotches upon the surface proved to be, on closer inspection, the points of the projectiles broken off and welded to the metal of the plate. The last shot started cracks from the center through the upper and lower left-hand holes to the edge of the plate.

The accompanying illustration is a photograph of two pieces of the Bethlehem high-carbon plate; fig. 1 shows the natural appearance of the steel, and fig. 2 is from the point of impact of the 8-in. shell. The difference is interesting.

The lack of uniformity in the tempering process was shown very markedly not only in the case of the last plate mentioned, but to a greater or less degree with all of the plates tested, and upon both days. Some means for securing a uniform degree of hardness over the whole surface of the plate will undoubtedly be devised.

This first showing in the manufacture of armor-plate was, for both the competing firms, a most creditable one; and it is doubtful if, taking into consideration the quality of the projectiles and the high velocities employed, equally good results have ever before been attained in the fabrication of armor.

Two more plates remain to be tested; but whether the rival firms will be content to rest their case upon the tests already had, or proceed to further trial, is unknown. In either case, it seems safe to predict that the decision of the Board will lie between the high-carbon, nickel-steel face-hardened plate of the Bethlehem firm, or the low-carbon nickel similarly treated plate of its Pittsburgh rival, with the chances in favor of the former as the matter now stands.

CAR COUPLERS.

AT a meeting of Railroad Commissioners of the different States, held March 3 last, a committee was appointed to secure action by Congress looking to uniformity in safety appliances for railroad cars. This Committee gave a public hearing to the representatives of different railroad companies and organizations of railroad employés in the rooms of the Chamber of Commerce, in New York, on November 10. A report of this hearing will be found on another page.

In sending out the call for the meeting, Mr. Moseley, the Secretary of the Committee, stated "that as 6,000 railroad employés were killed and 26,000 injured for the year ending June 30, 1889, and that the number is constantly increasing, therefore the importance of the subject is manifest not only to those directly concerned in railway operations, but to those who are interested in the cause of humanity." The appalling amount of pain and suffering which is indicated so faintly by the above figures would justify the use of much stronger language than that employed by the Secretary, who has done so much for the cause for which the meeting was held. To ignore the duty which is imposed on every railroad manager and every person who can exert any influence in lessening this awful amount of suffering is to incur a fearful responsibility. The members of the Committee who had charge of this meeting seemed to feel this responsibility; nevertheless, after a full hearing of all the parties who desired to be

heard, the Committee separated without reaching any conclusion, but with a more profound impression of the great difficulties with which the whole subject is surrounded than they had before the meeting was held. Those who gave their opinions and experience at the meeting also went away with the same impression.

The problem may be stated thus: The loss of life and limb being as indicated by the statistics quoted, how can it be diminished most, either by congressional legislation or otherwise? To this question no answer was given at the hearing.

All who attended the meeting were, however, agreed that one great cause of accidents in coupling cars was the want of uniformity in coupling appliances. The diversity, instead of being diminished by the action of the Master Car-Builders' and the American Railroad Association in adopting the vertical plane type of coupler, has been increased. The introduction of this new type has not only increased the diversity in the *species* but in the *genus* of couplers, which makes the danger much greater than a diversity of species does. Not only has the adoption of the Master Car Builders' type resulted in introducing a new genus, but it has led to the evolution of many new species of that genus, so that the present danger to the poor trainmen who must couple cars is now greater than ever before. The multiplication of the species goes bravely on, and unless checked in some way, the sacrifice of life and limb promises to go on at an increasing ratio. The imperative necessity for some preventive measure therefore becomes more urgent daily. The action which was contemplated by at least some members of the Committee who conducted the hearing was legislation by Congress making the adoption of the Master Car Builders' type of coupler compulsory on all railroad companies. To this there are, however, very grave objections. It is an American foible to suppose that almost any evil may be cured by legislation. It may be added that the more ignorant the legislators are, the greater is the number of subjects which they want to legislate about. Some of the objections to such legislation were very clearly summed up by Thomas Henry Farrer, the Permanent Secretary to the British Board of Trade, in giving his evidence, in 1877, before a royal commission appointed to inquire into the causes of accidents on railroads. He then said:

> General interference with the administration of railroads is objectionable on the following grounds:
> (*a*) By such interference you are setting two people to do the work of one. Double management is notoriously inefficient. One bad general is better than two good ones.
> (*b*) You set those who have less experience of management and less personal interest in the result to control those who have more.
> (*c*) Control is either apt to become formal and a sham, or if zealously and honestly exercised, to be rigid, embarrassing and a hindrance to improvement.
> (*d*) Many excellent things, the adoption of which is desirable for public safety—*e.g.*, the block system, interlocking points and signals, efficient brakes, properly constructed tires (car couplers might have been added) are not things which can be once for all settled, defined and prescribed, but things of gradual growth, invention and improvement. Had any of these been prescribed by law at any past time, they probably would not have been what they are now; and were they now prescribed and defined by law, future improvement would be checked. This is a most insidious form of evil, for we do not know the good which we thus prevent. It is no answer to say that Government control would be intelligent and would encourage improvement. It is not Government or its officers who invent or adopt inventions, and those who do so are far less likely to improve when Government has defined and prescribed a definite course, the adoption of which frees them from responsibility.

With reference to uniformity of car couplers, there is also the difficulty that there is no unanimity of opinion among those who are most interested in the subject. The Master Car-Builders and the American Railroad Associations have adopted the Master Car-Builders' type of coupler; but there are still an influential minority of railroad officials who are opposed to its use. The switchmen and yardmen appear to condemn it. Owing to its adoption by the associations referred to, it is being applied in a variety of forms to large numbers of cars; and it is useless to disguise the fact that its introduction thus far has increased instead of lessening the danger of the perilous occupation of coupling cars. In the present attitude of the question it is hopeless to expect to create immediate unanimity of opinion. This must be the result of evolution. It would be promoted very much if a brief report was made of each accident which occurs from coupling cars, giving the date and hour of the accident; how it was caused; the kind of coupler on each of the cars; the owners of the cars; the height of the draw-bars; their defects, if any, and the extent of the injuries to the person who was engaged in coupling. These particulars are intended only as suggestions, and are not by any means comprehensive. Doubtless others could be added to advantage.

Now, the legislation which is suggested is, that railroad companies should be required by Act of Congress to report to the Inter-State Commerce Commission, or some other body, all these and possibly other particulars regarding every accident from coupling cars which disabled the victim, and that full reports of such accidents be published monthly or quarterly—that is, oftener than once a year—so as to have more influence on railroad officers and the public than annual reports would have. Such reports would show which are the most dangerous couplers, would indicate the causes of accidents, and thus influence the opinions of railroad officers and the public, and tend to unanimity. Data of this kind would be analyzed by the technical newspapers, and if it once appeared that any form of coupler was specially dangerous, no railroad company could long continue its use in the face of adverse public opinion.

In an endeavor to bring about uniformity of couplers, the railroad associations have heretofore attempted to adopt some one standard. Such action has thus far failed in accomplishing its object. Whether it will ever succeed is still an open question. At any rate, there is now greater diversity than ever before. Now while there is no sufficient ground for pronouncing such action a failure, yet thus far it has not accomplished its object. How would it do, then, to attack the problem from the other or negative side?—that is, if we can't bring about uniformity, let us try to lessen diversity. Supposing that the members of the American Railroad Association should agree not to use any *new* pattern of coupler until it was approved by a committee of their own body appointed for the purpose. Then let them appoint a competent committee to sit in judgment on all new couplers, whether of the link-and-pin or vertical plane type which might be submitted to them for use by members of the Association. Such a committee might co-operate with a similar committee of the Master Car Builders' Association. Probably it would be found that investigations, experiments

and tests of couplers would require the services of a competent mechanical man, who could give as much of his time to the work of the committee as might be required. Without such assistance the work would be sure to be done in a more or less perfunctory way, as few or none of a committee could give more than a very limited amount of time to such duties. The person employed would do the real work of the committee, but under its advice, direction and approval; at the same time the action of the committee would be formulated by its own members.

One topic more: all interested—that is, railroad commissioners, railroad managers, car-builders, yardmen, switchmen and brakemen—are unanimously agreed that the height of draw-bars of freight and passenger cars should be uniform. The Master Car-Builders' Association has adopted the height of "2 ft. 9 in., measured perpendicularly from the tops of the rails to the center of the draw-bar when the car is empty," as the standard height for freight cars. To fix a maximum limit—say 2 ft. 11 in. and a minimum of 2 ft. 7 in.—and require railroad companies to conform thereto would not be a hardship. At present there is no general conformance to the Master Car Builders' standard of height.

If any compulsory legislation is adopted by Congress looking to uniformity and to hasten the equipment of freight cars with uniform automatic couplers, its provisions should for the present be confined to the adoption of the standard height of draw-bars, and to a requirement to report in detail the circumstances and causes of each accident, and these should then be made public by the authority to which they are reported every month or every quarter.

In the mean while, the American Railroad Association has also the duty of at least lessening the diversity of couplers, which is now increasing and not diminishing. Railroad companies argue against compulsory legislation to secure uniformity of safety appliances with bad grace, if at the same time they keep on increasing the diversity by their own action.

NEW PUBLICATIONS.

A Treatise on the Construction and Use of Milling Machines as Made by the Brown & Sharpe Manufacturing Company. The Brown & Sharpe Manufacturing Company, Providence, R. I.; price, paper, 75 cents, or cloth, $1.60.

This treatise is written chiefly for those who are not familiar with the use of the milling machine, but contains much matter of interest to those who are well acquainted with that excellent tool. It has special reference to the machine as made by the Brown & Sharpe Company, but its information is, of course, applicable to any machines of this class. It is of considerable size, having 162 pages, 94 illustrations and a number of tables.

Among other things it may be mentioned that a new classification of cutters is given, and much space is taken up by the consideration of the proper number of teeth in cutters, the best speed for mills and similar topics. Many milling operations are fully described, and there are chapters on Indexing, Compound Indexing and Cutting Spirals. The illustrations include views of a number of different machines, different forms of cutters, etc., and diagrams of changes.

Mexico. Bulletin No. 9, of the Bureau of the American Republics. Prepared by Arthur W. Fergusson. Issued by the Bureau of the American Republics, Washington.

This volume is similar in design and arrangement to the previous issues of the Bureau, and especially to the book on Brazil, which was recently noticed in the Journal. It contains a condensed historical sketch followed by a general description of the country, its natural features, resources, products, etc. There are chapters on public lands and land laws; immigration and colonization; wages, cost of living and conditions of labor; taxation, tariffs and nature of government; with a variety of other information. An appendix contains a description of the various railroad and steamship lines; a directory of the officers of the General Government, and a general mercantile directory. There is also an excellent map of the country.

The work of the Bureau of the American Republics appears to be well and carefully done. Its object has been previously referred to, and the publication of these monographs on the different countries of Central and South America should have excellent results.

Streets and Highways in Foreign Countries. *Reports from the Consuls of the United States on Streets and Highways in their Several Districts.* Issued from the Bureau of Statistics, Department of State, Washington.

This volume contains a number of reports sent in by United States Consuls, in answer to a circular from the State Department, giving information as to the condition of roads and methods of road-making in the countries where they are stationed. In Europe there are reports from Austria, Belgium, Denmark, France, Great Britain, Germany, Holland, Italy, Spain, Switzerland and Russia; in America, from Canada, Mexico, several of the South American States and the West Indies; and there are also reports from China, Australia and Egypt.

Some of these reports are excellent, and all of them contain some information. Many of them are illustrated by diagrams showing methods of construction and other details. Particulars of the cost of construction and maintenance are given in most cases, and the volume makes a serviceable book of reference.

It is of particular service at the present time, when so much attention has been called to the improvement of roads in our own country. A comparison of methods will be of service, and the statements of cost will be found convenient. The volumes issued by the State Department contain much useful matter, and the present one is especially worthy of note.

The Transit. No. 1, 1891. Issued by the Engineering Society of the State University of Iowa; Iowa City, Ia.

This is the first half-yearly number for 1891 of this publication, which is now in its second year, and which has been so far very creditable to the society of students by which it is maintained. The present number contains several excellent papers, two of which, at least, will attract attention among engineers. The first of these is the paper of Mr. Alden H. Brown, on Testing Cement by a Microscopic Method, which calls attention to the differences in structure or physical condition of different cements, and to the relation which exists between this structure and their strength and other properties. It is accompanied by a number of plates from photographs, showing the appearance of different cements under the microscope. These are very striking and are well worth a careful study by engineers who have to use cement. The suggestions made in the paper are good, and the whole matter is new and worth attention.

The other paper referred to is by Mr. E. A. Wallberg on Secondary Strains, and is a carefully written and well-studied account of the graphical method of determining these strains in bridge trusses.

The remaining papers are good and deserve more attention than space permits us to give them here. The Engineering Society of the Iowa University is apparently organized for serious work, and deserves credit for the progress shown in this volume.

TRADE CATALOGUES.

Chain Blocks. The Yale & Towne Manufacturing Company, Stamford, Conn.

This is an illustrated catalogue describing the various forms of the Weston differential pulley-block as manufactured by the Yale & Towne Company, with the addition of a report on the comparative efficiency of different blocks by Professor Thurston. Tables of dimensions required for various loads and other convenient data are included.

A List of Horizontal Boring and Drilling Machines. The Nicholson & Waterman Manufacturing Company, Providence, R. I.

This is a very neat and handsomely illustrated catalogue of the boring and drilling machines built by the company named. It is headed by the appropriate motto "Bore Away," and gives a list of a variety of machines of this class.

Ward's Patent Sectional, Safety, High-pressure Boiler or Steam Generator. Charles Ward, Charleston-Kanawha, W. Va.

This is an illustrated circular describing the Ward tubulous boiler, which has been heretofore described in our columns It is accompanied by a reprint, in pamphlet form, of the report of the Board of Engineer Officers of the Navy on the tests of this boiler, and the competitive tests of various coil and tubulous boilers. It was as a result of these tests that the Ward boiler was adopted for the new coast-defense ship *Monterey*.

Steam Pumping Machinery. The Deane Steam Pump Company, Holyoke, Mass. General Catalogue of Steam Pumps and Pumping Machinery.

The Horton Lathe Chuck: Illustrated Catalogue. The E. Horton & Son Company, Windsor Locks, Conn.

BOOKS RECEIVED.

Professional Papers of the Corps of Royal Engineers: Volume XVI. Edited by Captain W. A. Gale, R.E. The Royal Engineers' Institute, Chatham, England.

Reports of the Consuls of the United States to the Department of State: No. 131, *August*, 1891. Washington; Government Printing Office.

Some Experiments to Determine the Strength of American Vitrified Sewer Pipe. By Professor Malverd A. Howe. This is a reprint, in pamphlet form, of a valuable paper read by Professor Howe before the Engineers' Club of St. Louis.

Proceedings of the Fourth Annual Convention of the Train Dispatchers' Association of America and of the Train Dispatchers' Mutual Benefit Association. This is a very full report of the convention of the Train Dispatchers' Association, which was held in Toledo, O., in June last. It is issued in the form of a supplement to the *Telegraph Age*.

Papers of the Institution of Civil Engineers. London, England; published by the Institution. The latest of these papers received include the Design of Locomotive Cylinders, by J. H. Barker; the Proposed Railroad through Siberia, by W. M. Cuningham; Abstract of papers in Foreign Transactions and Periodicals.

Report of the Sixth Annual Meeting of the Illinois Society of Engineers & Surveyors: held at Springfield, Ill., January 28–31, 1891. Springfield, Ill.; published for the Society; price, 50 cents. This volume contains a number of papers read at the annual meeting, with reports of the discussions.

Transactions of the American Institute of Mining Engineers, Volume XIX: May, 1890, *to February*, 1891, *inclusive.* New York; published by the Institute.

Catalogue of the Michigan Mining School; with Statements Concerning the Institution and its Courses of Instruction. Houghton, Mich.; published by the School.

Smooth Track. An Exposition of the Principles of Permanently Smooth Track, wherein is Shown the Feasibility of Welding the Rails. By Philip Noonan. Lynchburg, Va.; published for the author.

Cornell University Agricultural Experiment Station. Bulletin 32, *October*, 1891. Ithaca, N. Y.; published by the University.

Sixth Annual Report of the Commissioner of Labor, 1890. *Cost of Production, Iron, Steel, Coal, etc.* Carroll D. Wright, Commissioner. Government Printing Office, Washington.

The Census of Canada: Bulletin No. 2. The Department of Agriculture, Ottawa, Canada.

ABOUT BOOKS AND PERIODICALS.

WITH the number for October 31 the COMMERCIAL AND FINANCIAL CHRONICLE, of New York, issued a supplement of 184 pages, giving a list of State, county and city debts throughout the United States. This is, we believe, the only compendium of the kind ever attempted, and its great value to bankers and investors is apparent. It gives in case of each State and municipality the population, resources and debt, with a brief statement showing rates of interest, dates of maturity of bonds and similar matters.

The first article in the OVERLAND MONTHLY for November is on Libraries and Librarians of the Pacific Coast. Other papers are on California Horse Farms; Administration of Law and Practical Education. There are several very entertaining stories and sketches, and also a bit of political history in the article on Gwin and Seward. This magazine is always readable, and is, moreover, valuable to all who want to know something of the Pacific Coast and its doings.

In the ECLECTIC MAGAZINE for November perhaps the most interesting articles are the second part of Mr. Murray's paper on Australia, from the *Contemporary Review*, and Professor Geffcken's on Russia, from the *New Review*. Other articles are given from the *National Review*, the *Westminster Review*, the *Saturday Review*, the *Fortnightly Review*, *Macmillan's*, the *Cornhill* and other English periodicals.

The fire in which its office was destroyed has not injured GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE, for the November number is an excellent one. Among the subjects treated are the New Jersey Geological Survey; a New Plan for Reaching the North Pole; the Peary Expedition to North Greenland; the Entrance to New York Harbor; the Ox-bows of the Mississippi, and the International Geological Congress. This magazine is by no means entirely technical, nor is it for teachers only; nearly all its articles are interesting to the general reader, and many of them contain valuable information not likely to be found elsewhere.

Among the papers in the POPULAR SCIENCE MONTHLY for December that will attract attention are those by P. D. Ross on Type Casting Machines, and on the rise of the Pottery Industry in the United States, by Edwin A. Barber. An extinct volcano in Connecticut is described by Professor W. M. Davis, and there are several other valuable articles.

A new catalogue recently issued by GOLDTHWAITE'S GEOGRAPHICAL EXCHANGE, No. 113 Nassau Street, New York, gives a long list of geographical appliances, maps, charts and works on geography. It would be hard to find a fuller or more complete list. The Exchange is now well established, and a visit will repay any one desiring to see a complete collection.

Among the books in preparation, by John Wiley & Sons, New York, is Part 3 of Professor Mansfield Merriman's treatise on ROOFS AND BRIDGES. This part treats of BRIDGE DESIGNS and will soon be issued.

The December number of SCRIBNER'S MAGAZINE is a holiday number and is chiefly devoted to stories and sketches. A series of articles on New Mexico is begun; they are handsomely illustrated.

The Smythe, Britton & Poore Company, Salt Lake City, Utah, has in press IRRIGATION CANALS AND OTHER IRRIGATION WORKS, by P. J. Flynn, C.E., which will be the most comprehensive work on this subject yet issued. Mr. Flynn has been a resident of Southern California for a number of years, and is considered an authority on this subject.

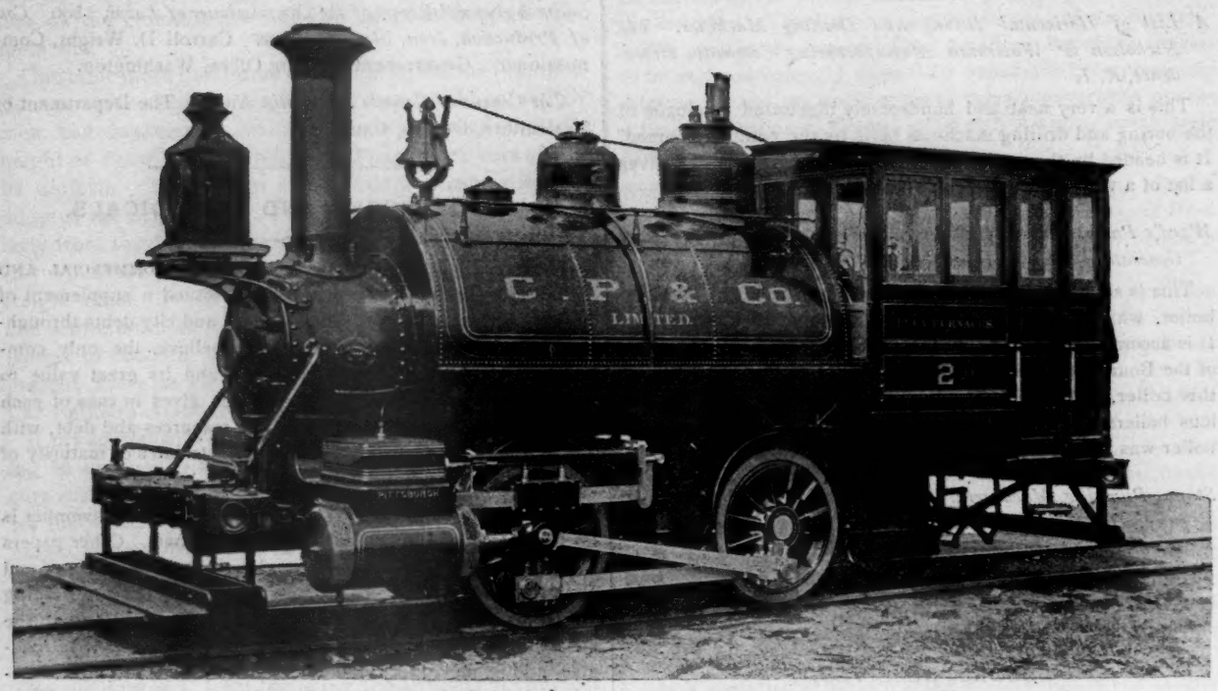
In the number of HARPER'S WEEKLY for October 24 there is a history of the Street Car, accompanied by many illustrations. The number for October 31 gives an account of the methods adopted in the high buildings of Chicago, with views of several of those buildings. In the number for November 8 there is a description of the cruiser *Baltimore*, with illustrations; articles on the Defenses of New York, and on Coal and Guns in the Navy; a paper on the Military Riding Schools of Germany, and a view and description of the new Pennsylvania Railroad Station in Jersey City.

In the November number of the ENGINEERING MAGAZINE Mr. Edward Atkinson writes of the lessons to be drawn from the Park Place Disaster. Other articles are on the World's Fair Buildings; the Perils of Coal Mining; Armored Warships; Chinese Silver Mining; the Manchester Ship Canal; Pumping Stations; Museum Building and Arrangement; and Building Laws.

The last number of the PROCEEDINGS of the United States Naval Institute is given up to the new Navy Instructions for Infantry and Artillery, which are here printed in full.

The ARENA for December has articles by Camille Flammarion, the French Astronomer, on Recent Discoveries in the Heavens. Among the other contributors are David A. Wells, Professor Funck-Brentano and Dr. Garland. This magazine retains always its independent and aggressive character, and is sure to have something well worth reading.

A very useful work is the ELECTRICAL TRADES DIRECTORY, which is issued each year by the London *Electrician*. The publishers wish to make it a complete list of electricians throughout the world, and will be much pleased to receive any information sent them. The book is published in January of each year.



FOUR-WHEELED SWITCHING LOCOMOTIVE.
BUILT BY THE PITTSBURGH LOCOMOTIVE WORKS.

The National Guard of California is the subject of the military article in OUTING for November. Other notable articles are Mr. Shinn's on Western Trappers, Mr. Page's on Fox Hunting in the Hudson Highlands, and Walter Camp's on Football; but there are several others which ought not to be passed over.

A FOUR-WHEELED SWITCHING LOCOMOTIVE.

THE accompanying illustration, from a photograph, shows a switching engine recently built by the Pittsburgh Locomotive Works for use in the yards of Carnegie, Phipps & Company, in Pittsburgh—a compact and well-designed machine for the purposes for which it is intended. As will be seen from the engraving, it is a four-wheel engine of the ordinary type, with a saddle tank and with the entire weight upon the driving-wheels.

This engine has cylinders 14 in. in diameter, with 22-in. stroke; the driving-wheels are 43 in. in diameter, and are spaced 6 ft. apart between centers. With a total wheel base of only 6 ft. it will be seen that the engine will take very sharp curves, and is well adapted for the service usually found in a yard of this kind, which is rather trying.

The tank, which is carried over the boiler as noted, will hold 750 gallons of water, and the fuel-box has a capacity of 30 cubic feet. The total weight of the engine in working order, with tank and fuel-box full, is 63,000 lbs., making a weight of 15,750 lbs. per wheel.

This engine may be compared in general design with the switching engine of the Boston & Albany Railroad, which was illustrated in the November number of the JOURNAL. That engine was somewhat larger in size, but

weighed very little more than the one now shown, as it was provided with a separate tender.

CAR-HEATER PATENTS.

To the Editor of The Railroad and Engineering Journal:

THE success of the appliances of the Consolidated Car-Heating Company has been so great that several manufacturers of more or less reputation have not hesitated to pirate our inventions. The Consolidated Company desires to warn railroad companies of these infringements, and thus to acquit itself of the obligation to give such notice. A flagrant violation of the Sewall coupler patents at the present time is especially noticed, where all the essential features are appropriated or closely imitated, while the unsuccessful attempt is made to evade the patents. The imitation is complicated and defective.

Another conspicuous instance is the placing of steam drums upon the cross-over pipes, which violates the well-protected invention of the Consolidated Company.

This Company will prosecute all such infringers of its patents and all those who use such infringements, while assuring railway companies of its indisposition to trouble them in such matters any more than is absolutely necessary for proper self-protection.

THE CONSOLIDATED CAR-HEATING COMPANY,
By WILLIAM G. RICE,
Vice-President.

ALBANY, N. Y., October 28, 1891.

TRIAL OF THE "CINCINNATI."

THE new ferry-boat *Cincinnati*, the launch of which was described in the JOURNAL for June last, is now completed and ready for service, and was given a trial trip on November 7. A number of invited guests were there, including railroad and ferry officers, steamboat men and others. The boat made a short trip down the Bay, running up the East River for a short distance, and then up the Hudson as far as Yonkers, and the trip was much enjoyed by the Company's guests, as was also the very excellent lunch which was served on board.

The new ferry-boat, which is intended for the Pennsylvania Railroad line between New York and Jersey City, differs from the ordinary type of ferry-boat employed on the waters around New York in two respects. Instead of paddle-wheels she has two screws, one at each end, following, in this respect, the example set in the *Bergen* of the Hoboken Ferry. She has also an upper cabin, which is a new departure begun by the Pennsylvania Company. The fitting and furnishing of the boat is very handsome, though free from an excess of decoration.

The use of the upper deck increases the passenger space very largely; there was also a special reason for it in the new elevated station which the Company is now building in Jersey City. Passengers will be able to pass from this directly to the upper deck of the ferry-boat, and will not have to descend until they have reached the New York side and crossed West Street on the new bridge built by the Company.

The upper cabin is one spacious saloon, 87 ft. long and 38 ft. wide, and is on a level with these stations. The walls and ceilings are finished in delicate pink tints, relieved with aluminum leaf; the electric lights are placed on silvered brackets with opalescent shades around the sides, with two large iridescent electroliers opposite the landing of the stairs. The floor is handsomely carpeted. The mahogany seats are fitted with bent wood seat arms secured by silvered fittings. This cabin has a seating capacity for 166 persons. The stairs to the lower cabins are inclosed with leaded glass partitions of handsome design.

The two lower cabins are each 144 ft. long and 15 ft. wide. The adoption of the screw propeller gives an unobstructed view of the entire cabin, the handsome mahogany stairs being the grand central feature. These cabins are decorated in light pearl-gray tints, with papier-mache festoons on the frieze, and roughened canvas panels relieved with aluminum leaf, producing a most harmonious effect. The floors are entirely covered with mosaic tiling, and the central domes over the stairs leading to the upper saloon are lighted by leaded glass.

Mahogany seats, similar in design to those in the upper saloon, afford a seating capacity for 304 persons. The electric lights, which are arranged along the sides of the cabins, are of the same style and finish as those in the upper saloon, with the exception of around the stairways, where they are in clusters; the total number of lights in all the cabins is 112, making it one of the most brilliantly lighted boats in ferry service.

All the cabins are heated and ventilated by the Sturtevant system, by which the entire volume of air is renewed every five minutes. The supply of fresh air is drawn down an air duct 38 in. in diameter from above the upper deck, passed through a heater, which brings it up to the desired temperature, and delivered into the cabins near the ceilings at a pressure which forces the foul air through ventilators located under the seats, which are connected by ventilating ducts with registers opening into the team gangway. The temperature is governed by electro-thermostats which control the valves that regulate the hot and cold air supply at the heater, thereby maintaining a uniform temperature.

The joiner work was built by the firm of John E. Hoffmire & Sons from plans furnished by the architects, Furness, Evans & Company, of Philadelphia.

The hull is of iron, and was built by the Samuel L. Moore & Sons Company, at Elizabethport, N. J. It has five complete transverse and two longitudinal bulkheads extending between the collision bulkheads at either end, making in all 14 water-tight compartments. The deck beams are of iron and are covered with iron plates, and the housing around the engines amidships, which extends above the hurricane deck, is also of iron, making the boat proof against any fire which might originate around the boiler or in the hull. All the floors and platforms in the hull are of iron, no wood being used below decks except the insulating strips for the electric light wires. The principal dimensions are: Length over guards, 206 ft.; length of hull, 200 ft.; beam over guards, 65 ft.; beam of hull, 46ft.; depth from deck to keel, 17 ft.; draft, 10 ft. 10 in.; displacement, 890 tons.

The boat has two Williamson steering engines of a type originally designed for this Company, and first placed in service on the ferry-boat *Chicago* five years ago. These engines are placed in the hull almost directly under the pilot-house, which gives direct connection from the steering wheels to the engine and uniform leads for the tiller rope. There is attached to the bell gear a specially designed indicator connected with the engine-room, which shows the engineer from which pilot-house the signals are being given. This is arranged so that the handles connected with the indicator have to be raised before the pilot can ring the go-ahead bell, thus preventing any mistake on his part. There is also a dial in front of the pilot, showing the direction in which the engines are working, so that he will always know whether his signals are being answered promptly.

The motive power is furnished by two steeple compound engines, each having cylinders 18 in. and 36 in. in diameter and 26 in. stroke. These engines were designed and constructed at the Pennsylvania Railroad shops in Hoboken, and are fitted with Canfield's balanced piston valve. This valve was described and illustrated in the JOURNAL for August last. The valves are driven by an adaptation of the Marshall radial gear, and on the trial trip appeared to work with great smoothness and precision.

The shafts are coupled between the two engines so that in case of accident to either engine or line of shafting, they can be disconnected and used independently. The shaft extends the entire length of the boat, with sectional propeller wheels at each end; these wheels are 8 ft. 9 in. diameter and 13 ft. 6 in. pitch and work together in either direction. At 120 lbs. steam pressure and 106 revolutions a minute these engines have developed 1,016 indicated H.P., giving a speed of 14 miles per hour.

The condenser is detached from the main engines and has independent air and circulating pumps. A grease extractor is connected with the exhaust pipes from the

various engines to prevent the oil used in lubricating the cylinders passing with the feed water into the boilers. In a separate compartment adjoining the engine-room are situated the heating and ventilating apparatus, an incandescent electric light plant of 200 lights capacity of 16 candle power each, and also one of the steam-steering engines. In addition to this large electric light plant there is one of 35-light capacity in the engine-room, which is connected by a special circuit to all the signal lamps and to a number of the cabin lights to be used in case of accident to the larger plant.

In another compartment situated to the right of the engineer as he stands on the working platform is the boiler-room, in which are two tubular boilers built of steel; each boiler is 10 ft. in diameter, 10 ft. long, and has 49 square feet of grate surface and 1,750 square feet of heating surface. There is, in addition, a donkey boiler 42 in. diameter and 6 ft. 9 in. in height; a circulating apparatus is fitted in connection with this boiler by which a uniform temperature is maintained throughout the main boilers while steam is being raised. At the rear of the boilers is another compartment in which is located the other steam-steering engine and a fresh water tank.

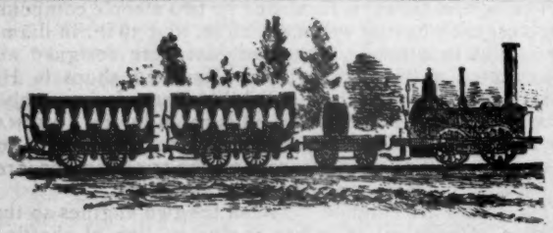
THE BORDENTOWN MONUMENT.

AN interesting ceremony took place at Bordentown, N. J., on November 12, when the monument which the Pennsylvania Railroad recently completed there to commemorate the first laying of track in New Jersey was dedicated. The first track on the Camden & Amboy Railroad was laid near Bordentown in the summer of 1831, and the old locomotive *John Bull*, which had been purchased for the road in England by Mr. John Stevens, was put upon the track in that year. Two passenger cars were built, and the first passenger train over the new track, which was then completed somewhat less than a mile, was run on November 12, 1831, conveying the members of the New Jersey Legislature, who had been brought down from Trenton for the purpose of convincing them that the operation of a railroad by steam was feasible.

The monument was thus dedicated on the 60th anniversary of the running of the first train, which seemed a very fitting opportunity.

The erection of such a memorial was first suggested by Mr. J. Elfreth Watkins, who is now Curator of the Transportation Department of the National Museum at Washington, but was formerly employed on the Pennsylvania Railroad as a Civil Engineer. The plan was cordially approved and taken up by the officers of the company, and the monument was erected under the immediate supervision of Mr. J. T. Richards, the Assistant Chief Engineer.

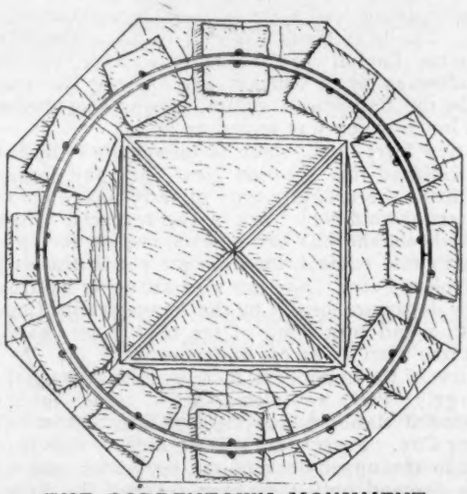
The monument itself, the general form of which is shown in the accompanying sketch, consists of a block of rock-faced granite 5 ft. square and 6 ft. in height. On the face of this block, which is toward the track, is a bronze plate, on which is a representation of the first train, with an appropriate inscription, which is given below:



FIRST MOVEMENT BY STEAM ON A RAILROAD IN THE STATE OF NEW JERSEY, NOVEMBER 12, 1831, BY THE ORIGINAL LOCOMOTIVE "JOHN BULL," NOW DEPOSITED IN THE UNITED STATES NATIONAL MUSEUM AT WASHINGTON. THE FIRST PIECE OF RAILROAD TRACK IN NEW JERSEY WAS LAID BY THE CAMDEN & AMBOY RAILROAD COMPANY BETWEEN THIS POINT AND THE STONE THREE THOUSAND FIVE HUNDRED FEET EASTWARD IN 1831.

It may be mentioned here that this first track was made of T rails of the form devised by Mr. John Stevens, and rolled for him in England, containing the germ of the form of rail which is now universally used in this country, and that these rails were laid upon blocks of stone bedded in the ground, the rails being held in place by spikes driven into wooden blocks inserted in holes in the stone.

The granite block composing the main part of the monument stands upon a pedestal some 3 ft. in height and octagonal in its general form. This is built of a number of the original stones used in place of ties, as described above, and upon the top of it and surrounding the base of the block is a ring composed of two of the old rails which had been preserved in the shops at Bordentown, joined together by some of the original joints, and resting upon a number of the old stone blocks which are placed at about the distance apart which they were usually placed in the



THE BORDENTOWN MONUMENT.

track. These relics were carefully gathered up—principally from the neighborhood of Bordentown and the old shops there—and are well authenticated, giving the monument peculiar interest. It may be noted here that as the Stevens rail was really the original of our present form of rail, so the clip joint which he used contains the germ of the modern fish-plate.

As noted in the inscription, the monument is placed at the western end of the track which was then laid. This track extended 3,500 ft. eastward, and the other end is marked by a plain granite post 5 ft. in height above the ground.

The ceremonies at the dedication of the monument were simple and impressive. A number of guests were brought by special train from Philadelphia, Trenton and other places, including, it was stated, one gentleman who rode upon the first train at the original trial trip in 1831. Mr. Isaac Dripps, who was afterward Master Mechanic of the Pennsylvania Railroad, was the engineer of the first train, and had been previously engaged in putting together the

old locomotive *John Bull* when it arrived from England. He is still alive and a resident of Philadelphia, but was, unfortunately, unable to come. A platform for the convenience of guests and speakers had been arranged alongside of the track, and General Stryker, Vice-President of the New Jersey Historical Society, was called upon to preside. With a few well-chosen words he introduced Mr. J. T. Richards, under whose charge, as above noted, the monument was built, who made a brief address, reciting the circumstances under which the monument was built, and transferring it to the custody of the United New Jersey Railroad & Canal Company. An address of acceptance on the part of that company by Mr. F. Wolcott Jackson, General Superintendent of the United Railroads of New Jersey Division, and then the main address of the day was made by Mr. Watkins. It was historical in its nature, giving an account of the organization of the Camden & Amboy Company, the difficulties which attended the first construction of the road, and its subsequent history, and referred at considerable length to the very important part taken by Mr. John Stevens and his sons in the building of the road and the designing of its substructure and rolling stock. It was exceedingly interesting in its nature, and we regret very much that space prevents us from reproducing it in full.

It is hoped that the good example thus set out at Bordentown will be followed elsewhere, and that memorials commemorating the prominent events of our railroad history may be erected elsewhere. The Bordentown monument is simple and tasteful and well adapted to the surroundings and circumstances, and it is solid enough to remain there to notify travelers for generations to come.

LYNN HAVEN BAY AS A HARBOR OF REFUGE.

[By Lieutenant Henry H. Barroll, U. S. N.

The geographical position of Cape Henry and its vicinity makes it highly desirable that there should here be constructed a harbor to allow refuge in threatening or in stormy weather to the shipping that may be either entering or departing from Chesapeake Bay, as well as to those vessels passing up and down this portion of the coast.

Cape Hatteras may well be considered the most dangerous point on the Atlantic coast of the United States. Several causes combine to make this locality a dangerous one to navigators.

From Cape Henry, the lower of the two points marking the entrance to Chesapeake Bay, the coast-line runs about south-southeast, for a distance of 100 miles, to Cape Hatteras. From Hatteras southward, as far as Fernandina, a distance of some 400 miles, the general trend of the coast is about southwest.

The line of direction of this southern portion of the coast has also determined the direction of the Gulf Stream. The shore-line has been much worn by the action of the waves, forming three marked indentations, known as Long, Onslow and Raleigh Bays, and just at the northern extremity of the last-mentioned indentation, and at the apex of the angle formed by the two lines of coast, is Cape Hatteras, a low, sandy point, scarcely visible even under most favorable conditions of weather, at a distance of six or eight miles, while dangerous and constantly changing shoals of hard sand stretch out to seaward fully 10 miles from the shore-line.

Here the Gulf Stream, transporting immense volumes of tropically heated water, and which is constantly communicating its warmth to the air above its surface, meets the cold Arctic or Counter Current, which flows along the upper Atlantic coast, and also encounters the cold air-walls, or atmospheric waves, sweeping from our northwest territory.

In recent years careful surveys, deep-sea soundings and temperatures taken with self-registering thermometers have accurately defined the limits of this great ocean current. At Hatteras the warm tropic river, flowing through its bed of colder waters, is breasted off to the northeast, but not until it has forced itself to within less than 40 miles of the coast; while in the latitude of the Delaware capes the outer cold wall forming its western bank is more than 300 miles further to the eastward.

It is almost impossible to realize the magnitude of this immense stream—one of the greatest arteries in that wonderful system of the ocean's circulation. At Cape Hatteras it has a width of about 100 miles and a depth of 600 ft., and flows at the rate of from 35 to 50 miles a day. These figures serve to illustrate the tremendous force that is constantly being brought to bear day and night against the apparently insignificant sand point, which, nevertheless, steadily deflects and determines the course of this mighty river of the sea.

The violent revolving storms which we now denominate *cyclones*, and which have their origin in meteorological disturbances occurring to the eastward of or in the vicinity of Barbados, sweep northward, the center of the storm generally describing a parabolic curve in its passage northward.

These gales are most liable to be disastrous to shipping when the vessel's position with regard to the storm's center is not accurately known. Modern science has demonstrated that these meteors can be made of service to navigation rather than the reverse, provided that the navigator carefully avoids what is now well known to be the dangerous semicircle of the storm. But unfortunately the storm's center, moving northward, as before stated, approximately on a parabolic curve, has a tendency to recurve or to pass from the northwest arm to the northeast arm of the parabola, returning, as it were, with redoubled force upon vessels that were previous to this well clear of the dangerous semicircle.

The majority of these tropical gales recurve between the limits of latitude 23° north and latitude 33° north. Cape Hatteras lies in about 35° north, and therefore during the progress of a cyclone vessels in the vicinity of this cape are always subjected to the dangerous sudden shifting in direction of the wind, and to the confused, irregular sea that such recurving produces.

Another feature that complicates the passage of Cape Hatteras, especially to vessels coming from the southward or the eastward, is the fact that here, owing to the extremely irregular profile of the ocean's bottom, the sailor, when approaching the shore, can derive little knowledge from the use of the lead. Coasting vessels can, to a certain extent, be assisted by frequent soundings, when rounding Hatteras from the northward, but when approaching from seaward—say from a direction southeast of the cape—the lead is practically useless.

Vessels arriving upon that stretch of our coast lying between Cape Henry and New York will find that the depth of water shoals with comparative regularity—an important factor in navigation. Eastward of Cape Henry the 50-fathom curve will be found at a distance of 65 miles from shore, and eastward of Barnegat the same depth is found at 75 miles, while it is impossible to get within 80 miles of Sandy Hook lightship before having first gotten into less than 50 fathoms.

On the other hand, at Cape Hatteras the 50-fathom curve approaches to within 15 miles of the shore-line and to within 7 miles of the Outer Diamond, a dangerous shoal, over which there are, in some places, only 5 ft. and 8 ft. of water. Ten miles from Cape Hatteras there are shoal spots having only 18 and 20 ft. of water. At a distance of 20 miles there is 100 fathoms, and at 30 miles a depth of 1,650 fathoms is reached. The irregular nature of the bottom here is well illustrated by the accompanying map, which is a reproduction of a part of a United States Coast Survey chart.

These causes combine to produce at Cape Hatteras most disastrous effects upon shipping either during the greater tropical gales or in the lesser and more localized disturbances, which can here always cause great damage to vessels subjected to their influences.

Thus early in life does the seafaring man learn to have a wholesome respect for Old Hatteras, whose white, hard sand beach represents the tombstone of many a gallant mariner.

"If the Bermudas let you pass,
Then look out for Hatteras."

This distich is well known to the mariner. It represents to him the experience of ages, extending from the obliteration of the prosperous and happy little Jamaican city of Savana la Mar, in 1780, or the scattering and wrecking of Rodney's fleet in 1782, when 90 vessels were lost and 3,000 seamen drowned, to the more recent March blizzard of 1888, or the recent wholesale destruction wrought upon the island of Martinique by the cyclone of August, 1891.

In order to guard against the many dangers that in this locality beset the sailor's pathway, the United States Government has ever been striving to place and keep here good, reliable aids to navigation.

For years attempts were made to keep the shoals marked by large iron buoys; but although these were moored with the heaviest class of chains and anchors, they were constantly being torn away by the powerful sea that here breaks during gales of winds. Along the stretch of beach extending from Hatteras to Cape Henry are 21 life-saving stations, spaced at distances of only about five miles from each other. The main light at Cape Hatteras is shown from a huge tower 191 ft. above the level of the sea. It is a powerful, first-order light, and is visible to a distance of 20 miles. Another smaller lighthouse, built close to the extreme point of the cape, throws another gleam over the outlying shoals, and in addition there is now under course of construction on the Outer Diamond an enormous lighthouse, whose cost is to be $500,000.

Surely the United States cannot be accused of neglecting to advance the interests of her commerce when we see her spend half a million dollars in order that the faint glimmering speck which guides the mariner by night shall be shown from a spot some eight or nine miles further to the seaward of this treacherous sand point.

Yet notwithstanding all the care thus taken and all the money thus spent, the mariner can never depend upon the assistance here provided for him. He may even be approaching the coast in broad daylight, with favoring wind and with perfectly clear weather, when a chilly wave of air from the northwest meets the warmer atmosphere above the Gulf Stream, and his vessel is soon enveloped in a dense fog-bank, and he must continue his way in danger and uncertainty.

To vessels that have encountered damage at sea, it is of utmost importance that there may be close at hand some port where repairs can be made. In the history of the sea too often has it been the case that after having successfully combated the fury of the fiercest gale, a noble ship has been forced to succumb to a lesser storm, brought to bear upon a broken, dismantled vessel, whose weary crew, after their hard-earned victory, were unable to cope with the lesser foe.

Owing to the direction in which the Gulf Stream flows, vessels that have been disabled anywhere in the neighborhood of this locality find themselves, in "clearing-up weather," to be to the northward of Cape Hatteras; and, therefore, it is very desirable to have immediately north of this point some convenient and well-sheltered port for which disabled vessels may steer.

Vessels leaving Boston, New York and other northern ports, and bound southward, can always find safe anchorage behind the Delaware Breakwater from gales of any nature, and can venture forth and pursue their voyage as soon as the position of the storm's center indicates that their course no longer lies through its dangerous semi-circle.

But after leaving Delaware Breakwater the next protection for vessels of draft of 8 ft. and over is only to be found in some sheltered port in Chesapeake Bay. Lynn Haven, an open roadstead just to the westward of Cape Henry, furnishes to vessels protection against southerly winds; but owing to the exposed nature of this roadstead to the northward, it is at present but a doubtful shelter, since in the case of a revolving storm the shifting in direction of the wind would leave the vessel on a lee shore with a sweep of the entire Chesapeake Bay to roll in a sea of such magnitude that she could not safely ride at anchor before it.

The only safe course in such a case would be to continue to Hampton Roads, passing through the narrow gateway at Fort Monroe, and anchor where there is shelter from all directions. But this necessitates the sailing of a further distance of some 20 miles—a track which the vessel must also retrace in order to get once more upon the sailing line to her destination. Freights are low, competition is sharp, and owners of vessels are exacting, and therefore the master, even with all indications of an approaching gale, will sometimes hesitate to add to the security of his vessel by sailing this additional 40 miles.

If his vessel is bound southward he has probably had comparatively fair weather since leaving the vicinity of the Delaware Breakwater, 100 miles to the northward. He argues with himself that it is only an equal distance further south to round Cape Hatteras; and he generally decides to "chance it on the course to the port" rather than to make a harbor at the expense of so much time and trouble.

Perhaps all goes well; and after two or three days' buffeting he weathers the gale, and saves on his voyage the 40 extra miles to Hampton Roads and back. Perhaps all does not go well; and then the bones of his staunch vessel go to add to the litter on the wreck-strewn beach from Hatteras to Nag's Head.

In some cases the master makes a compromise, and takes an anchorage in the open roadstead at Lynn Haven, trusting to his ability to get under way at the first sign of a change in the direction of the wind; but this, although sometimes made necessary, owing to stress of circumstances, is not a wise proceeding.

These considerations illustrate how much the immense commerce of Chesapeake Bay and its numerous tributary rivers would be enhanced by the building of a breakwater here, just inside the entrance to the bay. There would then be here provided a safe and convenient harbor only 100 miles distant from Cape Hatteras, and also at the final point of leaving the more sheltered Chesapeake Bay for the great ocean itself.

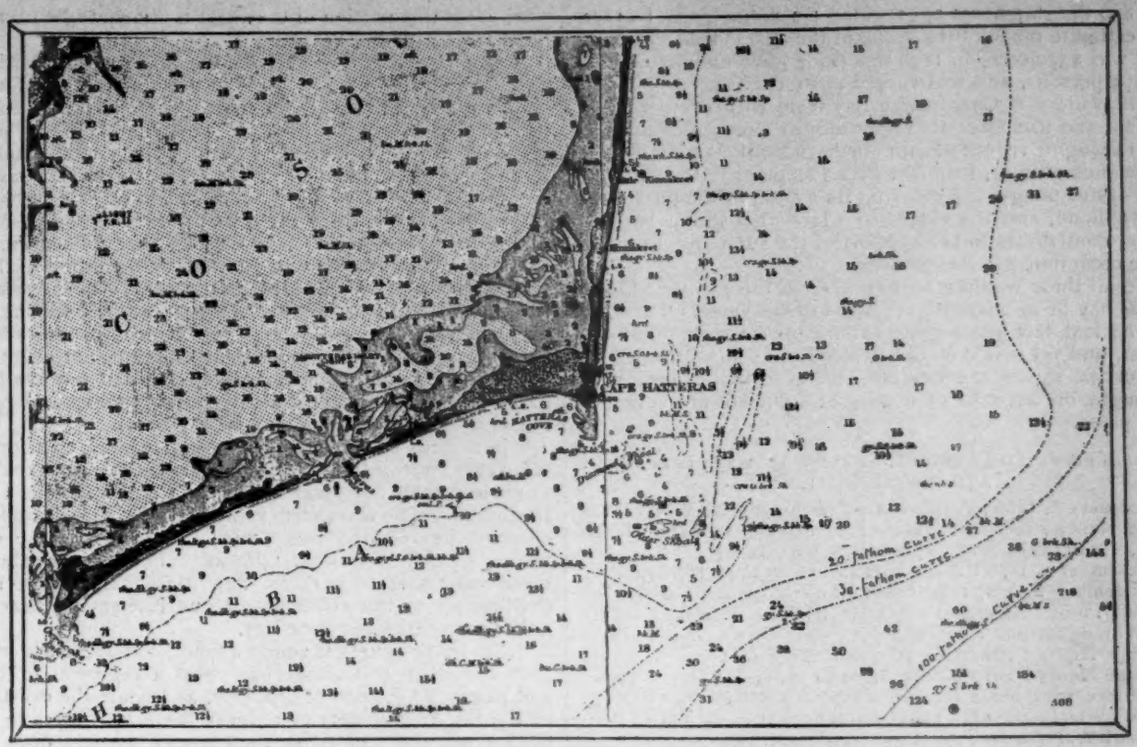
Within the last few years there has been established between Chesapeake Bay and northern ports a system of transportation by barges, several of which will proceed to sea in tow of a single tug. This class of transportation has now assumed such great proportions that its necessities should not be overlooked, and a secure harbor just inside of Cape Henry would be of vital importance to this class of vessels.

In many cases vessels would use this harbor in passing, merely coming here to report for orders or to send information to their owners. At Cape Henry is located a sea coast signal and telegraph station, and vessels could thus report their arrival, and receive instructions where to proceed. Little time would be lost by even passing vessels, were they to make a harbor here in anticipation of heavy weather; while perhaps to a sailing vessel the time required to reach the secure anchorage in Hampton Roads would be represented by the better portion of a day.

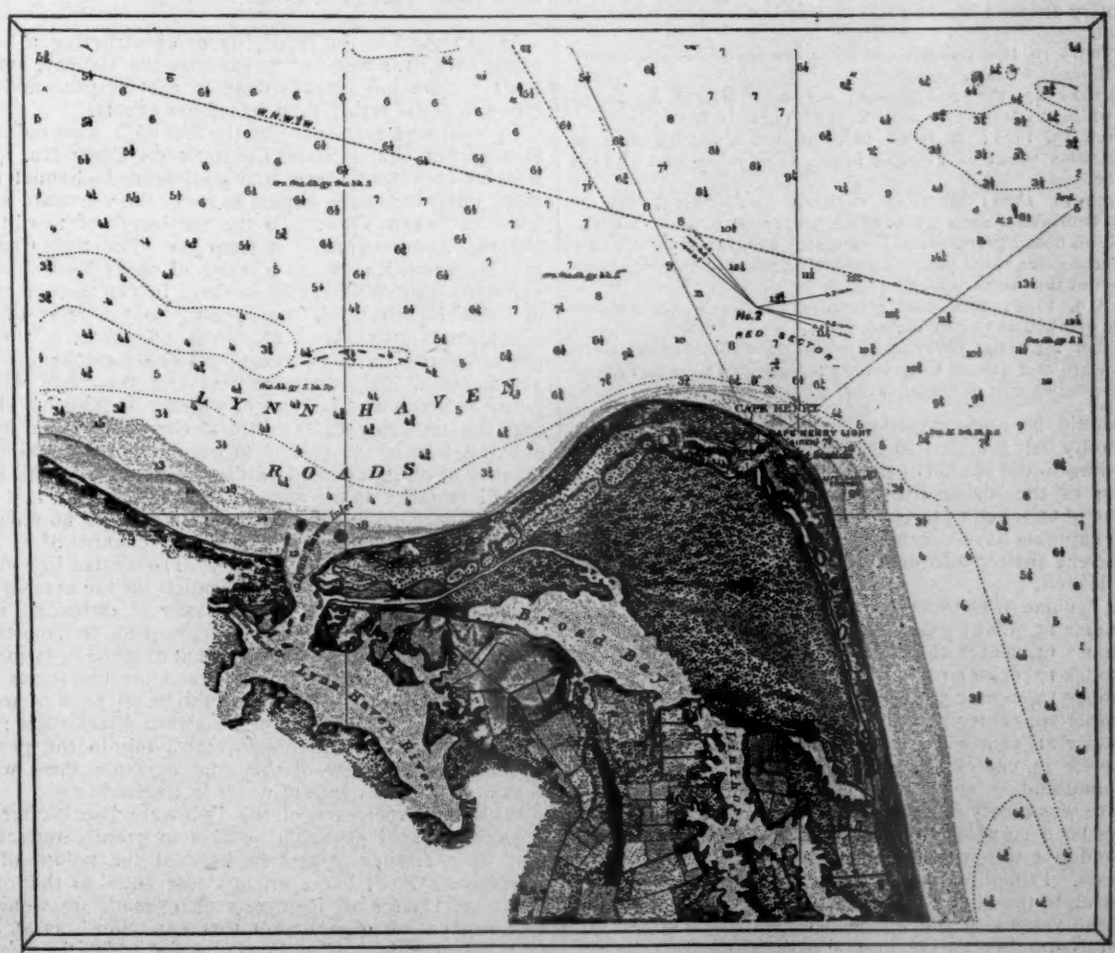
It would be difficult to estimate the saving of life and property by the establishment of a harbor of refuge at this place. Thousands of lives and millions of dollars' worth of property are daily passing through this great artery of our commerce. It has been estimated that that portion of the commerce that passes through Hampton Roads is equal to that which ascends to the city of Baltimore. To this must be added the traffic of the numerous tributary streams, the York, Rappahannock, Potomac, Patapsco, etc., their shores lined with prosperous cities and thriving towns.

The late wonderful development of the South under the last few years of heavy crops and a great influx of Northern capital seeking investment has been nowhere more marked than here at the southern gateway to the ocean. Urged on by the prosperity of the territory to the south and west, Virginia's seaports, all of which are situated on Chesapeake Bay, have been taxed to their utmost to receive and trans-ship the produce that is being constantly crowded here to meet water transportation.

The great coal mines of the western part of Virginia, pouring their steady stream of rich bituminous coal into the grand harbor of Hampton Roads, constantly demand additional wharves and piers for the handling of their ever-increasing output. In 1886 the coal shipments from one of these piers—Lambert's Point—aggregated 504,000 tons.



CAPE HATTERAS AND VICINITY.



CAPE HENRY AND LYNN HAVEN ROADS.

FROM COAST SURVEY CHART NO. 131.

In 1890 the shipments aggregated 1,250,000 tons. In 1878 the estimate made of the value of the oyster trade of Norfolk was $350,000; in 1890 this trade gave employment to 18,864 persons, and was valued at $3,124,444.

The waters of Chesapeake Bay teem with every variety of fish, and its shores are under almost close cultivation in the raising of vegetables for northern markets. Each day thousands of craft, from the ocean steamer to the diminutive oyster pungy, are cleaving its waters in the pursuit of a livelihood, and the extent to which this grand body of water contributes to the support of the surrounding maritime community is inestimable.

To all these would a harbor here at the entrance to the great bay be of advantage. A list of the vessels that have in the last few years gone ashore on this portion of the coast, and yet inside of the protection as now afforded by the capes, shows the amount of havoc that is each year wrought on account of a want of sufficient protection at this place.

VESSELS REPORTED AS ASHORE, OR SUNK, BETWEEN CAPE HENRY AND SEWALL POINT, VA.

February 8, 1886: A two-masted schooner sunk W. N. W. of Cape Henry; schooner *Anthea Godfrey* sunk in Lynn Haven Bay. (Afterward blown up by U. S. engineers.)

December 9, 1886: A tug-boat ashore on Cape Henry.

November 2, 1887: Schooner *Wallace J. Boyd* ashore on Sewall Point; American schooner *William T. Phelps* ashore on Willoughby Spit; American schooner *Carrie Holmes* ashore at Cape Henry; American schooner *Mary D. Cranmer* ashore at Cape Henry; British bark *Alabama* ashore at Ocean View; American schooner *Elias Moore* ashore 3 miles east of Ocean View; brig. (nationality unknown) ashore at same place; British bark *Harvester* ashore at the same place.

December 30, 1887: American schooner *Catharine W. May* sunk in 10 fathoms 12¾ miles W. ½ N. of Cape Henry.

January 2, 1888: Steam yacht *Mohican* ashore on Willoughby Spit.

February 16, 1888: American schooner *Maud Seward* ashore on Willoughby Flats.

February 27, 1888: American schooner *Alfred E. Smyrk* sunk while at anchor two miles east of Thimble Light.

March 13, 1888: A large three-masted schooner sunk in 5½ fathoms south of Thimble Light, a few miles east of Fort Monroe.

March 18, 1889: American bark *E. L. Pettingill*, just returned from Asia, sunk a few miles northwest of Cape Henry, and all on board perished. (This vessel had for several years weathered gales in all parts of the world, only to founder at her anchors at this home port.)

April 9, 1889: American schooner *Charles P. Sinnickson* totally wrecked at Ocean View.

October 25, 1889: *General Harrison*, rig unknown, ashore 3 miles north and west of Cape Henry; American schooner *Rover* ashore 3 miles east of Ocean View.

It would be unnecessary to continue the list, which is constantly being added to in a more or less rapid degree according to the season of the year. The most noticeable feature of the above list is the disaster following the cyclone of October 13 to October 23, 1887. In later years vessel captains have become more wary of trusting to the insufficient shelter afforded by the present roadstead of Lynn Haven.

The cyclone of October 13–23 is plotted as follows:

October 13, about 300 miles south of Havana.

October 14, center about 50 miles north of Campeche.

October 17, center 100 miles south of Galveston.

October 19, center 50 miles south of Mobile.

October 20, center about 75 miles west of Hatteras.

October 21, center about 75 miles east of Boston.

October 23, center about 50 miles north of St. Johns, Newfoundland.

There was plenty of time for the approach of this storm to have been signaled to vessels passing along our coast, and no doubt this was done at every signal station along the coast. Probably hundreds of vessels remained in harbor owing to the fact of its approach having been signaled, yet those vessels of the above list mentioned under the date of November 2 were undoubtedly attempting to get an anchorage inside of Hampton Roads, or had taken anchorage at Lynn Haven, and upon the approach of the storm's center in this locality were driven ashore; and a week later this portion of the coast is shown to be literally lined with stranded vessels.

A record of disaster such as the above speaks with no uncertain voice. Of all classes of investment, that of shipping represents probably the least wealth in proportion to the number of people who are its owners. Each small schooner is usually owned in part by the captain, and in some cases each member of the crew has an interest in the profits of the vessel. So, in such cases as that of November 2, 1887, when the report goes forth to Washington of the eight vessels whose wrecks lined this stretch of coast, it represents not only the loss or detention of these vessels, but probably also the loss of many a bread-winner for those at home waiting with expectant eyes for the sail that is never to return. Not only the loss to the crew of their place, their occupation, their clothing, but also their share in the vessel's profits; while those at home are beggared as much as are the stout men who have struggled through the breakers and gained the beach.

The records of the Life-saving Service show that for the two years ending June 30, 1891, there occurred casualties to no less than 160 vessels between Cape Fear and Cape Henlopen. The estimated value of these vessels and the cargoes they carried was $3,404,485, of which the estimated sum lost was $1,146,890. There were aboard these vessels 1,116 persons, and it is gratifying to note that, owing to the efficiency of our Life-saving Service, only 51 of these lives were lost.

From these figures it would appear that there are every year risked on this dangerous coast a regiment of lives and nearly $3,500,000 of property, and while the exertions of the Life-saving Service reduced the loss of lives to less than 5 per cent. of those risked, such fortune does not befall the ships and their cargoes, since of this property more than 33 per cent. is lost.

With regard to the feasibility of constructing a breakwater here, it is well to first examine the locality, and see what Nature has already done in that respect, and then strive to assist rather than retard her efforts.

By reference to the plate on the first page, a reproduction of a part of United States Coast Survey Chart No. 131, it will be seen that there is a well-defined channel lying close along the shore, almost as far to the westward as the hotel at Ocean View. To the northward of this littoral channel, and separating it from the Main Ship Channel into Hampton Roads, are a series of shoal banks making eastward from Willoughby Banks. Just to the northward of Lynn Haven Inlet, the opening to the river of that name, and lying about 1⅔ miles off shore, is the last portion of this series of shoals—a small bank having only 3¾ fathoms, while between this and the shore will be found as much as 5 fathoms of water. This clearly shows that the tendency of the littoral currents caused by the ebb and flow of the tide is to cut out the channel at the expense of piling up sand on the banks. This small shoal should be taken as the nucleus of a breakwater, and with a clear approach at each end there would be no difficulty experienced in keeping at all times a channel of at least 20 ft. at lowest stage of the tide. The dotted line on the map shows approximately the location for the breakwater.

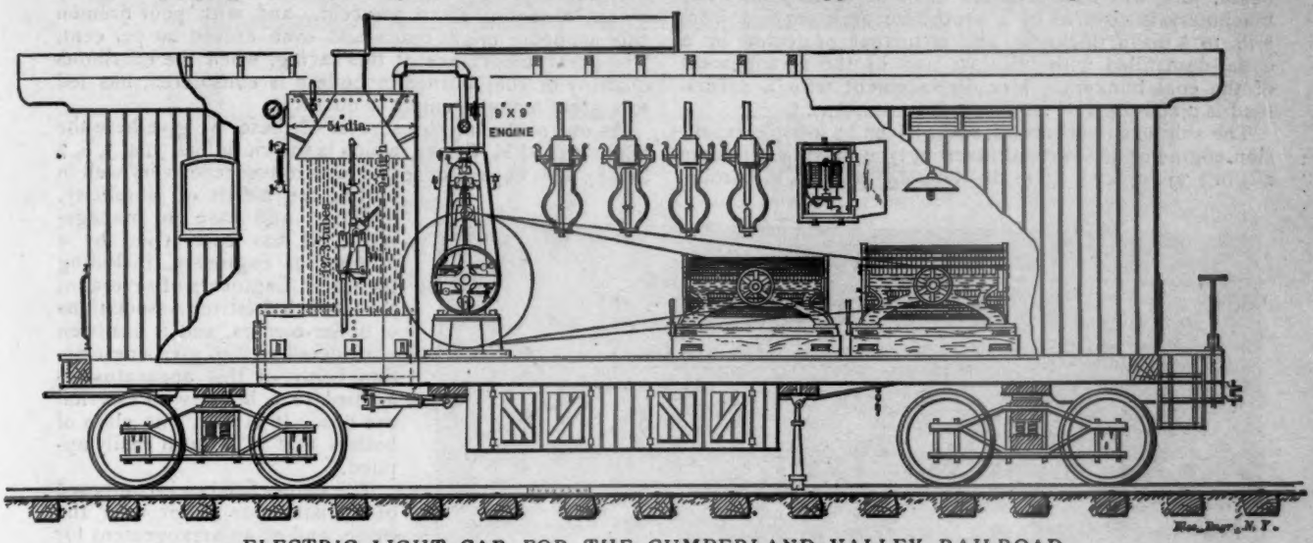
The question of expense can easily be estimated, since it only consists in calculating the cost of the transportation and depositing of a sufficient amount of stone to form here a reef of large enough size to break the obnoxious seas from the northward. There would be no need of an ice-breaker, as in the case of the Delaware Breakwater; and with each end of the breakwater lying in the general direction of the flow of the tidal currents, there would always be a good depth of water in the harbor.

With the experience of the Delaware Breakwater our engineers would probably be able to greatly reduce the cost of a similar protection here at the mouth of the Chesapeake Bay; but even at a cost equal to that of the Delaware Harbor of Refuge, such expenditure would be well repaid. A government that can afford, as at Hatteras, to expend a half million dollars to add to the safety of its sailors, can well afford also to expend an equal amount for a harbor of refuge at this, the point of all others on the Atlantic coast where such protection is needed.

A PORTABLE ELECTRIC LIGHTING PLANT.

THE accompanying illustration, for which we are indebted to the *Electrical Engineer*, shows an electric lighting plant in use on the Cumberland Valley Railroad. It is described in the *Engineer* by Mr. C. S. Hull as follows:

Having recently read of portable electric lighting as being a new scheme, I send you prints of a portable electric light plant designed and built by me for the Cumberland Valley Railroad, at the Chambersburg, Pa., shops, in 1883, and which has been in constant use up to date. The accompanying illustration explains the construction.



ELECTRIC LIGHT CAR FOR THE CUMBERLAND VALLEY RAILROAD.

We use this plant for lighting at wrecks, and rent it for picnics, camp-meetings and often for public lighting. The capacity of the plant is forty 2,000-candle-power and two 65-candle-power incandescent series lamps.

This plant consists of a fifteen 2,000-candle-power lamp dynamo, built by the Thomson-Houston Electric Company, 1880, purchased by our Company in 1882; a twenty-five 2,000-candle-power lamp dynamo, spherical type, purchased in 1886, operated by a 35 H.P. vertical automatic engine and a 40 H.P. vertical submerged flue boiler, built by the Taylor Manufacturing Company, Chambersburg, Pa. The plant has given entire satisfaction.

MR. EDISON'S RAILROAD INVENTIONS.

(From the *Electrical Engineer*.)

OUR columns contain this week the bitter protest of a correspondent against the various reports that have appeared in the newspapers with regard to some new work of Mr. Edison in electric railroads. It is a matter of fact that, as there stated, the effect of these newspaper articles has been to put a check upon immediate investment in existing methods of electric railroad work, and for that reason they are to be deplored. But it is hardly fair to hold Mr. Edison responsible for the exaggerations and bulls crowded into these reports. Some day the newspapers will perhaps employ skilled men on their technical work as they now do on that which relates to music and the drama; but in the mean time we must be thankful things are no worse. If this talk arrests development, the Edison General Company will suffer with the rest, and even his worst enemies will credit Mr. Edison with shrewdness enough to see that palpable and obvious fact. There is, however, offset to the harm done. It is a great thing to have the whole country talking and thinking about electric railroads, for in due course misinformation will be corrected and the truth shine clear. Having tried ourselves for ten years past to engage public attention on electric railroad work, we are glad to see that the subject is now ripe for a nation's thought. If Mr. Edison, too, can add to existing methods one by which low voltage may be used, it is cause for general congratulation, even though to many of us lowering voltage looks like a decided step backward. We are all gainers by every extension of the field, and in the long run not a cent less will be spent in railroad investment. Moreover, there is no evidence that existing methods or apparatus will be wiped out, even by the most revolutionary invention. Each new invention simply restricts other ways of reaching results to their strictly legitimate sphere of greatest profit and benefit; and as far as electrical plant is concerned, the depreciation is generally so slight that, even in spite of the great advances made, apparatus is still running with satisfaction that belongs to the very early stages of the art. In a word, we do not see the slightest reason why any single railroad project entered upon or even broached should not be carried to a conclusion. When Mr. Edison puts his plan on the market it will be time enough to discuss its actual effect.

THE UNITED STATES NAVY.

THE last report of the Chief of Ordnance recommends the construction of an experimental breech-loading rifle of 16-in. caliber. The forgings can now be obtained in this country and the gun can be finished in the shops at the Washington Navy Yard.

THE MONITOR "MIANTONOMOH."

This ship may be said to be really the first battle-ship of the Navy to go into commission. She was ordered to be ready for service at the New York Navy Yard last month, although some work still remains to be done upon her.

The *Miantonomoh* was originally one of the double-turreted monitors completed about the close of the War. She was put in commission in 1866, having then an armament of four 15-in. smooth-bore guns, and soon after made a cruise to Europe. From that time she was in service but little until 1885, when it was decided to rebuild these vessels, with iron hulls and other improvements.

The ship is now of iron throughout, the hull being divided into 87 water-tight compartments. She is of the original low freeboard monitor type, the deck being only 25 in. above water; the sides have 7-in. armor. The chief dimensions are: Length, 262 ft.; breadth, 55 ft. 2 in.; mean draft, 14 ft.; displacement, 3,820 tons.

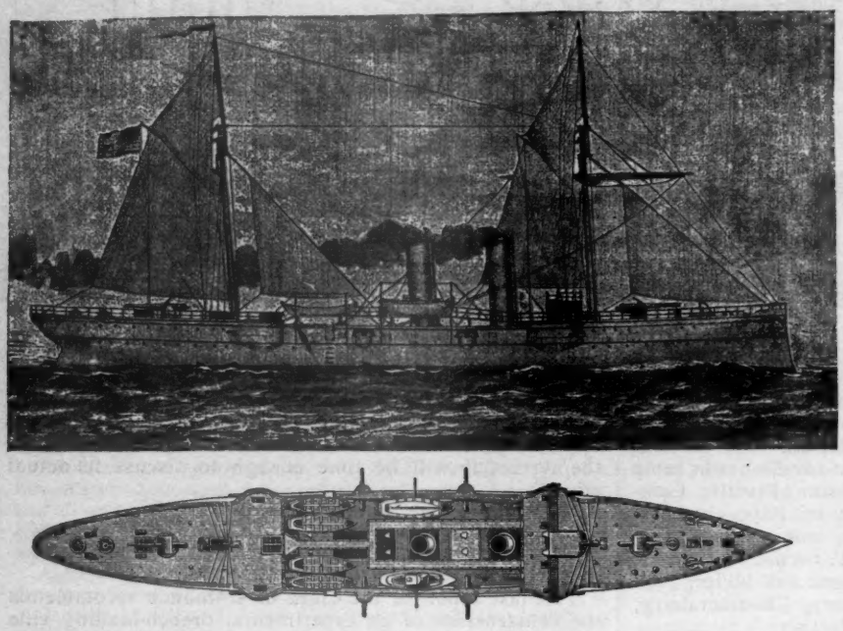
The ship has twin screws, each screw being driven by a compound engine, with cylinders 32 in., 40 in. and 40 in. in diameter and 42 in. stroke. Steam is furnished by four boilers, carrying a working pressure of 80 lbs. She is not expected to make over 14 knots an hour.

The *Miantonomoh* carries four 10-in. breech-loading rifles, the first of the new guns of this caliber in service. Two of these guns are in each turret, on hydraulic mounts. The turrets are 24 ft. 6 in. in diameter, and are armored with steel plates 11½ in. thick. In addition to the large guns there are four 6-pdr. Hotchkiss guns on deck and two revolving cannon in the tops of the military masts with which the ship is provided.

LAUNCH OF THE "DETROIT."

The new cruiser *Detroit* was launched from the yard of the Columbian Iron Works in Baltimore, October 28. She is an unarmored steel cruiser 257 ft. in length and 37 ft. beam, and will have a mean draft of 14 ft. 6 in. The machinery is covered by a protective deck varying from ⅜ in. to ½ in. in thickness, and is further protected by a coffer-dam filled with cellulose and by the arrangement of the coal bunkers. Her displacement with a normal load is 2,000 tons.

The ship has twin screws, each driven by a triple-expansion engine of the vertical inverted type, having cylinders 26½ in., 39 in. and 63 in. in diameter and 26 in. stroke.



THE NEW CRUISER "DETROIT" FOR THE UNITED STATES NAVY.

The engines are expected to develop 5,400 H.P., with 160 lbs. boiler pressure and running at 185 revolutions. There are three double-ended boilers 11 ft. 8 in. in diameter and 18 ft. 8 in. long, and two single-ended boilers 11 ft. 8 in. in diameter and 9 ft. 2 in. long. The forced draft is on the closed ash-pit system.

The coal bunkers will hold 200 tons, and extra bunkers are provided so that 435 tons can be carried. With the latter supply the cruising range is 8,950 knots at a 10-knot speed. The contract speed with full power is 17 knots an hour.

The armament carried will consist of two 6-in. and eight 4-in. rapid-fire guns. The secondary battery will include four 6-pdr. and four 3-pdr. rapid-fire guns and two 37 mm. (1.46-in.) revolving cannon. There will also be six torpedo-tubes.

The *Detroit* has two masts and will have a fore-and-aft rig. The general appearance of the ship is shown by the accompanying sketch, which is taken from the report of the Bureau of Construction.

Cruiser No. 9, which is not yet named, is nearly ready for launching at the same yard. There are altogether three of these 2,000-ton cruisers under construction, and they are expected to be very useful and handy vessels for cruising work. The armament is a heavy one for their size.

NOTES ON COMBUSTION.

By C. Chomienne, Engineer.

(*Continued from page* 501.)

POSSIBLE ECONOMIES IN COMBUSTION.

We have already seen that the loss by incomplete combustion of gases is still from 5 to 6 per cent. of the total heat, even under good conditions, or about 10 per cent. of the heat actually utilized. If, then, we wish to do away with this loss, and at the same time to reduce the loss by the chimney, by avoiding an excess of air, we can easily obtain a saving of 10 per cent., and with poor firemen this economy might reach and even exceed 20 per cent. The great importance of this saving, when the enormous quantity of coal burned in boilers is considered, has led to a great many attempts to obtain it.

As one of the latest instances of these, we give here the apparatus of M. Criner, which is shown in figs. 3, 4, 5, 6, 7 and 8. This apparatus seems to have succeeded very well in uniting the merits of simplicity, low cost and ease in management. It has been tried by a number of engineers, including the Chief Engineers of several of the French District Associations of boiler-owners, and it has been considered well to give a description below of this apparatus, as applied to a boiler with external fire-box. It is with this class of boilers that it is most easily applied.

The Criner fire-box is composed of a distributor of air over the grate, and of an arrangement for mixing the gases as they leave the fire-box.

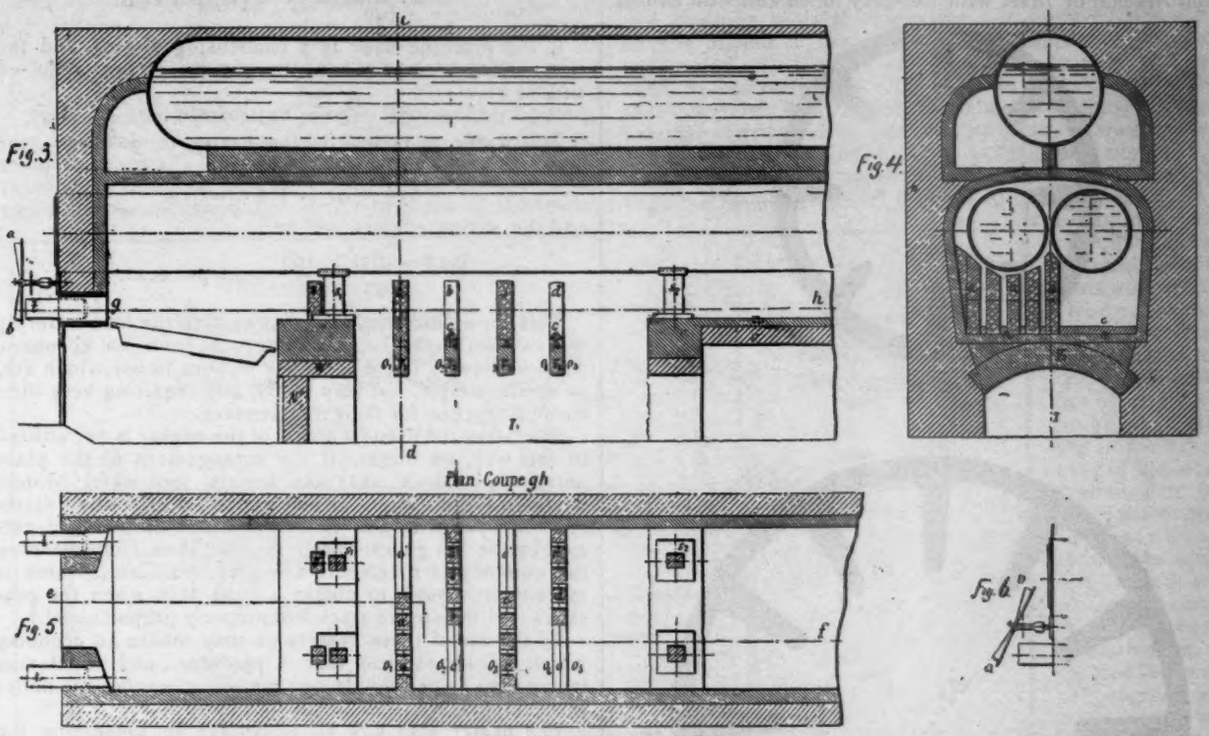
The air distributor is shown in figs. 3, 5 and 6, and on a larger scale in figs. 7 and 8; fig. 3 is a longitudinal section; fig. 4 a cross-section on the line *c d*, and fig. 5 a horizontal section on the line *g h*.

The distributing apparatus is composed of a tube *t*, figs. 3, 5 and 8, which passes into the fire-box, one end being open to the air, while the other opens in the fire-box above the grate. In this tube is a valve or damper, by which the quantity of air introduced in a given time can be regulated. There is also a sand-box *S*, figs. 7 and 8, resembling an hour-glass, which has two compartments *a b*, and which contains very dry sand. An arm *V* extends horizontally into the hole which connects these two compartments, and thus serves to increase or diminish the speed with which the sand passes from one to another. This sand-box has two distinct movements; it can oscillate around the points of suspension *x x*, and the support *y y*, which forms the socket, permits it also to rotate. This support is fixed in front of the fire-box in such a way that the opening of the tube *t* will be completely closed by the sand-box when it is vertical. The sand is then in the lower compartment. When the tube *t* should be opened and give free access to the air, it is sufficient to turn the sand-box 180° around the support *y y*. In this way the compartment *b* which was below is raised above, and the weight of sand which it contains causes the sand-box to oscillate around its axis *x x*, forcing it to take the inclined position *a' b'*. It thus leaves the mouth of the tube *t* open until the sand has run down in a sufficient quantity to make it resume the vertical position *b'* coming to *a* and *a'* to *b*. Thus the damper of the tube *t* serves to regulate the quantity of air introduced, while the arm *V* serves to regulate the length of this introduction. Two of these apparatus are employed for each generator.

The arrangement for mixing up the gases, which is intended to mix them completely before they reach the point where the flame is extinguished, is usually composed of a series of bars or columns *a*, *b*, *c*, *d*, figs. 3 and 5, of fire-brick, or some other refractory substance, placed in rows behind the bridge. Under the influence of the draft the gases are obliged to pass around these obstacles in their way. There is, then, a sharp agitation which brings rapidly in contact all the elements which can combine at a very high temperature, in such a way that combustion is hastened, and will end before the point of extinction is reached. These columns being in the hottest part of the fire are carried to a red heat, and then serve by their own temperature to light the gases which have become cooled in their passage from the fire-box, when fresh coal is thrown upon the grate. Moreover, becoming heated by their contact with the currents of burning gases, they will give out by radiation a portion of this heat to the boiler under which they are placed. It will be seen that, thanks to the air distributor, which permits us to give all the air required at the moment when the coal is distilled, we can have less air in excess during the period which follows the distillation, either by partially closing the register or by increasing the thickness of the layer of coal.

One point which is somewhat surprising at first sight is an increase in power which this system gives to boilers, and this has brought it into much favor even among mining companies, where the refuse coal which is usually burned has very little value. If what we have said above is carefully considered, however, it will be seen that there are three reasons for this:

1. The gases leaving the mixing apparatus are much hotter and the boiler will absorb a greater amount of heat.



THE CRINER FIRE-BOX.

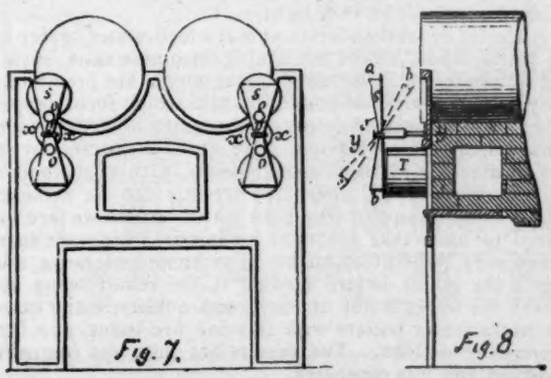
2. The columns or bars act by taking up a portion of the heat of the gases, which they radiate to the boiler.

3. Combustion with less excess of air permits us to burn more carbon with the same total quantity of air introduced through the grate.

These Criner fire-boxes are also very good smoke-consumers. The Dieuze Salt Works, which have 13 of these fire-boxes and use a coal of mixed quality, report an increase of 29 per cent. in power with a saving of 12 per cent. in fuel. At the mines of St. Etienne, where there are 34, a statement extending over a considerable length of time gives an increase of 23 per cent. in power and a saving in fuel of 15.8 per cent. It may be noted that the air distributor only may be applied to tubular boilers where the arrangement for mixing the gases cannot be employed. A number of other instances might be cited.

We may also mention a new tube for tubular boilers which is intended to increase the action of the heat of the gases, and consequently the surface of absorption. This is the ribbed tube, invented by M. Servé, of Givors, and which is shown in figs. 1 and 2, which give sections of tubes of this kind respectively of 50 mm. and 80 mm. in diameter.

We have heretofore, said that the radiating power of gases being almost nothing, it follows that their heat can be transmitted only by contact, and that the solution of the problem consists in the increase of the surface of contact; it is for that reason that M. Servé has devised this new tube. The gases which enter the tubes travel in parallel layers through the tube and the portions in contact with the surface are quickly cooled; but as they always form the external part of the gaseous column, they form a very poor conductor for the heat contained in that part in the central portion of the tube, so that the total mass reaches the chimney without having given up a proper quantity of its heat. M. Servé has substituted for the ordinary smooth tube a tube carrying inside longitudinal ribs which penetrate almost to the center and carry away the heat from the gases, saving a considerable



amount, which would otherwise be lost, while the metal, being a quick and easy conductor, carries to the outside the heat of the different layers of gases.

The use of these tubes, as shown by experiment, has increased the vaporizing power of boilers to an unexpected degree. From a number of comparative trials made at the Arsenal of Brest with ordinary tubes and with ribbed

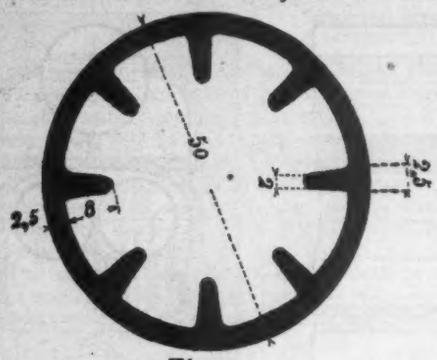


Fig. 1.

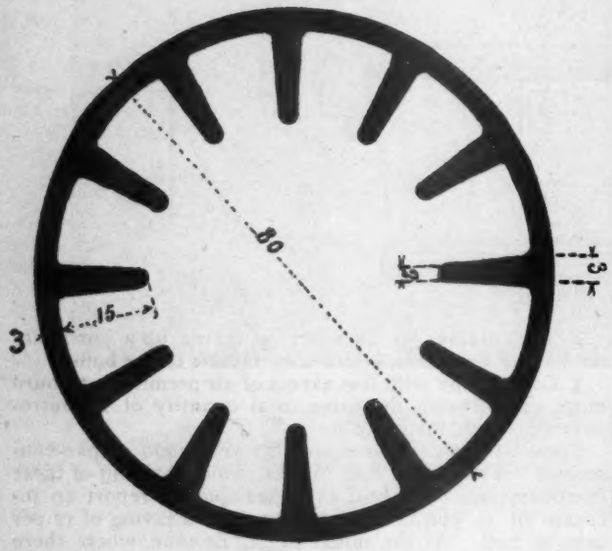


Fig. 2.

tubes in the same boiler, it was found that the average economy realized with natural draft was 15 per cent. and with forced draft 20 per cent., which is a very notable saving. It was found, moreover, that the ribbed tubes did not in the least impede the draft or injure the firing qualities of the boiler.*

HEATING FEED-WATER.

There are two systems of heating feed-water for boilers.

1. By the exhaust steam.

2. By utilizing the flame or heat of combustion after its passage through the fire-box.

The majority of the steam-engines in use are non-condensing, and the exhaust steam is allowed to escape into the air. If this exhaust steam is used to heat the feed-water a considerable saving may be realized.

If we take a boiler producing steam at an effective pressure of 6 kg. (about 85 lbs.), each kilogram of steam requires

$$606.5 + 0.305\,t - t' = 655 - 15 = 640 \textit{ calorics}$$

for its vaporization, if water is taken from the reservoir or tank at a temperature of 15° Cent. (59° Fahr.).

If, on the other hand, the temperature of the water is raised to 90° Cent. (194° Fahr.) by a good heater, the consumption of heat will not be more than

$$655 - 90 = 565 \textit{ calorics},$$

and the saving will be

$$\frac{(640 - 565) \times 100}{640} = 11.7 \text{ per cent.}$$

If the machine used is a condensing engine, and the water is taken at 30° Cent., the amount of heat required will be:

$$655 - 30 = 625 \textit{ calorics}.$$

If the water is raised by the heater to 90° Cent., the amount of heat will not be more than

$$655 - 90 = 565 \textit{ calorics},$$

and the saving effected will be:

$$\frac{(625 - 565) \times 100}{625} = 9.6 \text{ per cent.}$$

This shows incontestably that heating the feed-water by the exhaust steam is advantageous from an economic point of view. There are many heaters in use which are, as a rule, simple, not very costly, and requiring very little care or expense for their maintenance.

Whenever the exhaust steam of the engine is not utilized in this way, we ought, if the arrangement of the plant permits, to place near the boilers feed-water heaters having a large heating surface and tubes of a small diameter* in such a way as to utilize a part of the heat carried by the hot gases, and to prevent them from reaching the chimney at a temperature over 200° Cent., which is more than enough to obtain a good draft when the passages and the smoke-stack are properly proportioned.†

By the use of these heaters we may realize an economy which will be not less than 8 per cent., and which may increase to 12 per cent. when the water reaches the boiler at a temperature from 80° to 100° Cent.

The heater also has an advantage in preserving the boilers, since by its use we avoid the violent expansion and contraction which is produced when the feed-water is cold. There is also the further advantage that by heating the water, we cause the precipitation of the soluble calcareous deposits which are found in the feed-water, where they are dissolved by the presence of an excess of carbonic acid. Under the action of a temperature below 100° Cent. such water will deposit the greater part of the carbonate of lime which they contain, so that the deposit in the boiler will be very light.

It should be well understood that a feed-water heater has no action upon waters containing insoluble salts, such as the sulphate and chloride of lime, which are precipitated only at the moment of ebullition, and which form deposits attaching themselves firmly to the most heated surfaces. The difficulty of removing these deposits formed by impure water is a serious inconvenience in tubulous boilers, even in those forms where the fire-box can be removed. These boilers require very pure water, unless we are prepared to undertake frequent cleanings, which are sometimes very difficult to effect. For such boilers we must purify the water before feeding it, the result being that where the water is not of very good quality, many manufacturers prefer boilers with interior fire-boxes, of a form more easy to clean. The repairs are then less frequently required and less expensive.

For heaters of this class the water passing through should be forced in the opposite direction to the gases—that is to say, the cold water should reach first the surfaces last exposed to the action of the hot air and gases. It is best also to keep these heaters as clean as possible, and not to permit them to be covered with soot or ashes, in which case the results would be decreased to a serious extent.

* Similar trials have been made recently in this country with very nearly the same results. It may be mentioned that the Servé ribbed tubes are now being tested in actual service in a number of marine boilers, and are shortly to be tried in several locomotive boilers.

* The conducting power of liquids being low, to favor the transmission of heat it is best to make the heating surface of a heater as large as possible, and to make the tubes as small as the nature of the water will permit, in order to diminish the thickness of the layer of water to be heated.

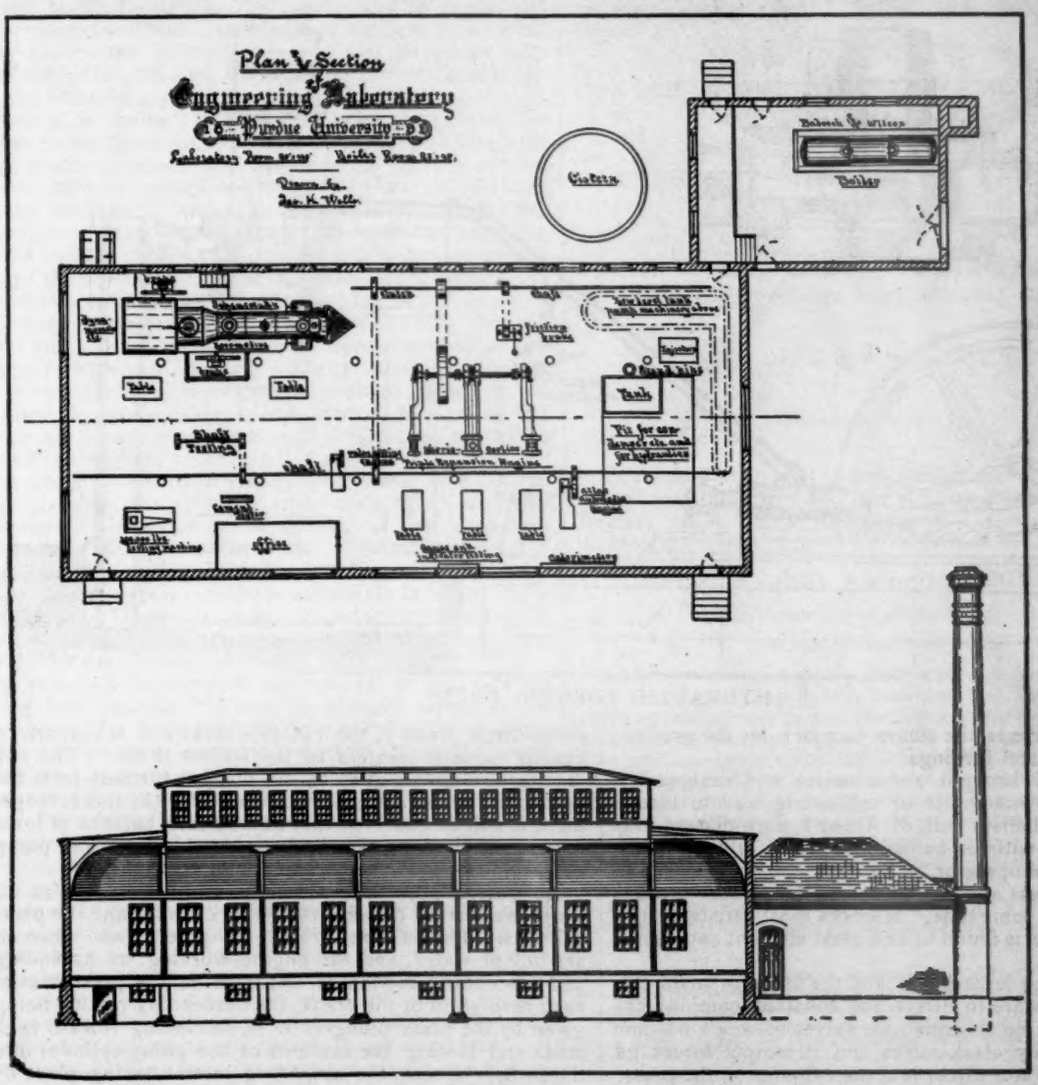
† To determine the temperature of the gases passing to the smoke-stack, we generally use a mercurial which is placed directly in the current of smoke, and so arranged that it can be read without removing it. If the temperature of the gases exceeds 330° Cent., a pyrometer must be used.

The influence of the amount of air furnished is much less in boilers furnished with heaters having large surfaces, than in those which have not this addition. A very slight difference—about 3 per cent.—exists in favor of a strong draft for apparatus of this class, while in others there may easily be a loss of 12 per cent. where the draft is too strong and too great a quantity of air is furnished.

(TO BE CONTINUED.)

AN EXPERIMENTAL LOCOMOTIVE.

THERE is now being placed in the Engineering Laboratory of Purdue University, at La Fayette, Ind., a 17 × 24-in. Schenectady locomotive, which is to be so mounted that its performance may be carefully tested while being run under conditions quite similar to those of the track. The engine is one of its maker's standard forms, having drivers 63 in. in diameter, and weighing 85,000 lbs. It is completely equipped with the Westinghouse driver-brake system, and has a headlight from the A. E. Williams Company, of Utica, N. Y. The driving-wheels of the locomotive, instead of resting upon a rail, will be supported by large wheels mounted on shafts which are carried by fixed bearings. These bearings are bolted to a heavy foundation. The locomotive is held in its position on top of the supporting wheels by its draw-bar, which on the road would be used to connect it with the train, but which in the present case is to be connected to a peculiar form of dynamometer or scale. This dynamometer is to weigh the pulling tendency exerted by the engine in a horizontal direction. When the driving-wheels revolve, the engine, instead of moving ahead, remains stationary and the supporting wheels turn backward. In other words, instead of the engine moving ahead on the track, the track—that is, the periphery of the supporting wheels, moves behind. It will be seen that, if the supporting wheels turn without friction, there will be no tendency on the part of the engine to move horizontally in one direction more than another. If, however, a resistance is offered to the turning of the supporting wheels, the engine will tend to move horizontally with a force equal to this resistance. The plan of mounting includes four powerful Alden friction brakes fixed to the shafts carrying the supporting wheels. By means of these brakes the engine may be loaded with a pulling resistance which may be varied from almost nothing up to the full pulling capacity of the engine. By this means, therefore, the engine may be run continuously under conditions similar to those on the track, and it is expected that while thus run, many of the problems relating to the efficiency of the locomotive can be much more carefully studied than when actually running along the road. A Sturtevant steam blower is located above the engine, but not connected with it in any way, for the purpose of taking up and carrying away whatever may be discharged from the locomotive stack. This insures perfect ventilation and freedom from dust in the laboratory.

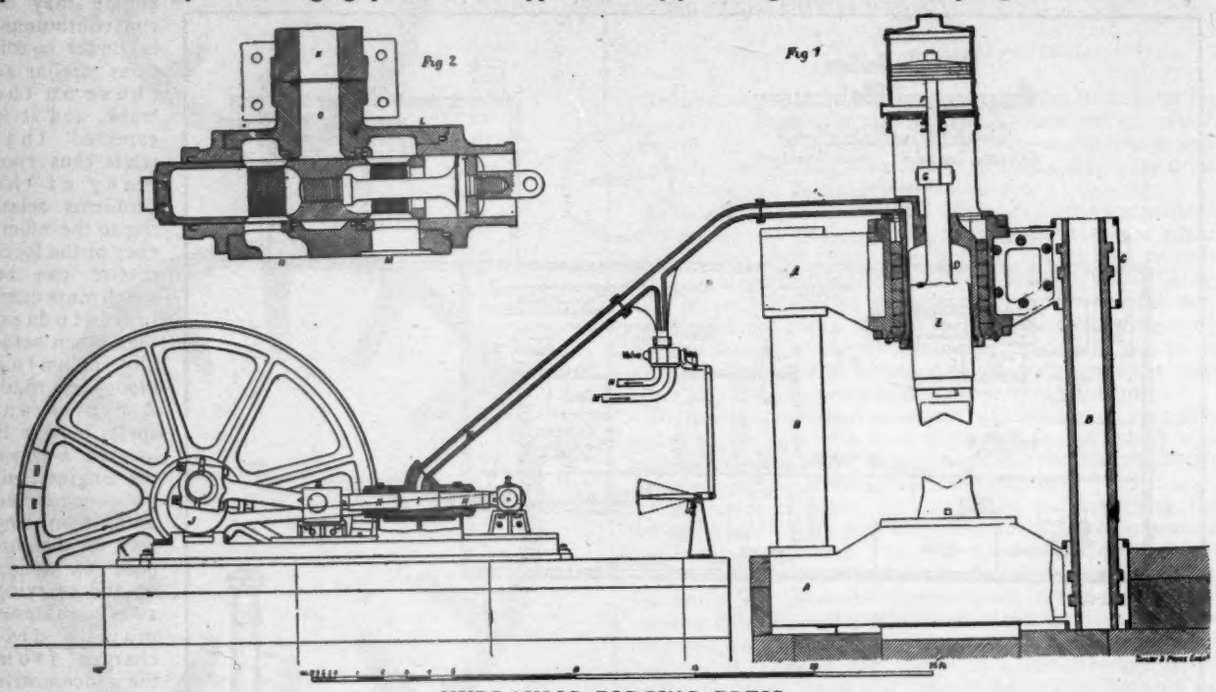


It may be added that the locomotive described in the foregoing forms but a single feature of the new Engineering Laboratory at Purdue. There is besides a Harris Corliss triple-expansion condensing engine having cylinders 8, 15 and 22 in. in diameter by 24 in. stroke; a 100-H.P. Babcock & Wilcox boiler; a 12-H.P. Otto gas engine; all provided with accessory apparatus necessary for careful work in testing. There is also an experimental stand-pipe, in which may be maintained any desired head for hydraulic experiments, and in connection therewith are high-level and low-level tanks with weir-plates between. There are two Morris centrifugal pumps; a No. 5 Dean steam-pump; several injectors; a 13-in. Leffel water-wheel. There is also a 100,000-lbs. Olsen testing machine; a 2,000-lbs. Olsen cement tester; a 10-H.P. transmitting dynamometer; a 50-H.P. Alden friction brake, and a large amount of small miscellaneous apparatus.

THE FORGING PRESS.

(Paper read by W. D. Allen before the British Iron and Steel Institute.)

In the production of heavy forgings from cast ingots of mild steel, it is essential that the mass of metal should be operated on as equally as possible throughout its entire thickness. When employing a steam hammer for this purpose it has been found that the external surface of the ingot absorbs a large proportion of the sudden impact of the blow, and that a comparatively small effect only is produced on the central portions of the ingot, owing to the resistance offered by the *vis inertiæ* of the mass to the rapid motion of the falling hammer, a disadvantage that is entirely overcome by the slow though powerful compression of the hydraulic forging press, which appears destined to supersede the steam hammer for the production of massive steel forgings.



HYDRAULIC FORGING PRESS.

The press now brought under notice was designed to be more or less automatic or self-acting, and to insure the perfect parallelism both of flat or square masses and of round shafts without being dependent for their truth on the skill of the operator.

The forging press about to be described has been erected and in operation some time. It works most satisfactorily, and, on the whole, is found to be a most efficient and useful tool.

In this press the force-pump and the large or main cylinder of the press are in direct and constant communication. There are no intermediate valves of any kind, nor has the pump any clack-valves, but it simply forces its cylinder full of water direct into the cylinder of the press, and receives the same water, as it were, back again on the return stroke. Thus, when both cylinders and the pipe connecting them are both full, the large ram of the press rises and falls simultaneously with each stroke of the pump, keeping up a continuous oscillating motion; the ram, of course, traveling the shorter distance, owing to the larger capacity of the press cylinder.

The diagram herewith shows the press and pumps. The top and bottom portions of the framing *A A* are alike, and from the same pattern, each consisting of two castings, held by bolts and steel hoops, as shown.

The main columns *B B* are hollow; they have annular projections or rings *C C* cast at each end, which fit into corresponding recesses, cast in the top and bottom frame pieces.

The large press cylinder *D* is fitted and held in the top frame; the anvil block rests in the bottom frame. Weldless steel hoops are shrunk on to the cylinder to give additional strength, as clearly shown in section. *E* is the main ram. It has a strong shank to it, which passes through the top of the cylinder, acting as a guide. *F* is a steam cylinder with piston, the piston-rod of which passes through the gland at the bottom of the cylinder and is attached to the shank of the ram. *G* is a cross-head working in guides, thus preventing the ram from turning round.

The force-pumps may be appropriately termed "duplex," the ends of faces of the two plungers *H H* advancing and receding to and from each other simultaneously at each stroke. They work into opposite ends of the pump cylinder *I*. This cylinder has no bottom, and becomes simply a strong tube. The two plungers are worked by a three-throw crank *J*, the two side throws of which are on exactly opposite centers to the middle throw. The two side throws give motion to the plunger furthest from the crank, and the strain is a thrust or push. By this arrangement it will be observed that an absolute balance of force is obtained, and all strains between the crank and pump are avoided.

As before observed, a free communication is at all times maintained between the pump cylinder and the press cylinder. This is done through the pipe *K*, and when all are full of water, and the engine working, an ascending and descending motion is imparted to the press ram at each revolution of the crank, the descending motion being given by the press plungers *H H*, advancing toward each other and forcing the contents of the pump cylinder into the press cylinder, the ascending motion taking place by means of the steam piston, which, on the return stroke, raises the ram, and forces the water back on to the pump plungers as they recede from each other; so that as long as there is no waste of water by leakage, and its quantity is not increased or decreased, the press ram will continue to oscillate at the same distance from the anvil, and could only operate on work of that exact size. The ram has, therefore, to be raised or lowered to suit the various requirements of work in hand, and to effect this a source of supply of water under a pressure of about 250 lbs. has to be provided, which, when admitted into the press cylinder, has sufficient force to overcome the power of the steam in the steam cylinder, sending the steam back into the boilers. By this means the ram is rapidly brought down any required distance; on the other hand, the power of

steam immediately raises the ram upon the water being allowed to escape.

The valve used for the rapid admission and escape of water becomes, therefore, rather an important feature and is shown in fig. 2. It consists of a cylindrical casing, having a hollow cylindrical valve or plunger, working endwise through hydraulic leathers; at each end of this valve or plunger very fine slits are sawn lengthwise through its sides or walls. The principle of the valve is the allowing of the admission and escape of water through the fine slits, by moving the valve endwise until the fine slits pass the hydraulic leather; the set of slits at one end of the valve being for the admission of water, and those at the other for the escape.

L is the casing bored through and fitted with hydraulic leathers shown in section. *M* is the inlet, *N* the outlet, and *O* a passage into the pipe *K*. The valve or plunger is fitted pretty freely into the casing, and is capable of being removed endwise. It is hollow, with a solid division in the center, the hollow forming a sort of cup on each side of the solid part, and through the side walls of these cups the fine slits are cut.

When it is desired to bring the press ram down, the valve is moved endwise to the left until the fine slits pass the hydraulic leather, and a passage is thereby opened from the inlet *M* through the slits, and water is admitted into the passage *O*, and then on to the pipe *K*, and the ram at once descends. When it is desired to raise the ram the valve is moved to the right, and water passes out through the other set of slots, and away by the outlet *N*, and the ram at once ascends by the action of the steam.

It should be observed that at the time the slits pass the leather the low pressure only is in operation, and at the moment of impact of the ram upon the work the valve is always in its neutral position, the position shown in the diagram, the plain body of the central portion of the valve, with a cup leather on each side, being all that is exposed to the great pressure.

The proper time for the additional water is when the pump plungers are receding from each other, and the valve should always be put in its neutral position before the ram face comes upon the work. This arrangement of valve is found to operate most successfully, and the change of position of the ram is effected as quickly as is necessary or desirable. The valve, being in perfect equilibrium, is most easily worked by a handle, brought to a convenient position for the operator to see the work in hand.

The ram may be raised or lowered for its entire range in very few seconds. It can be brought down to the greatest nicety a little lower down each stroke, enabling forgings to be made correct to dimensions, or in case of any sudden occurrence, when it is found undesirable for the impending pressure to take place, the stroke can instantly be averted by moving the valve to the right, although the face may even be in contact with the work. The ram, in fact, is perfectly under control, and almost as lively as the tup of a hammer. An accumulated power is obtained by two heavy fly-wheels on the crank-shaft of the pumps, the momentum of which imparts very great force at the moment of impact of the ram, at which time the cranks approach and turn their centers.

As a security against accident, and a precaution against this force becoming too great, a system of safety-valves has been devised (although not shown in the diagrams). It consists simply of a steam cylinder and piston, the piston-rod of which works into a small hydraulic cylinder that is in constant connection with pipe *K*. Steam is admitted into the steam cylinder at the opposite end to that of the piston-rod, and when the hydraulic pressure on the end of the piston-rod becomes sufficient, it forces the steam back into the boilers. Thus, if the steam piston is 60 in. in diameter, and the piston-rod 6 in. in diameter, and the pressure of steam 50 lbs. per circular inch, a hydraulic pressure on the end of the piston-rod of 5,000 lbs. per circular inch will be an equivalent, and a pressure exceeding that will force the steam back into the boilers, and relief for the water will thereby be obtained.

The press ram makes a stroke of 2¾ in., and its diameter is 30 in., so that at a pressure of 3 tons per square inch (deducting the area of the shank) we have a power of 1,700 tons. But, of course, no pressure is developed until resistance takes place; hence no power is lost or consumed (except what is lost by friction) until the ram face comes into actual contact with the work, and then sufficient pressure only is developed and consumed to do the work. The press was fitted by W. & J. Galloway & Sons, of Manchester, and with the exception of the steam cylinder *F*, is constructed entirely of steel. The form and strength of all the parts have proved to be capable of sustaining the sudden and great strains to which they are subjected, and no springing or flinching takes place—the ram always descending to the same spot, whether it has to press 2 in. into an ingot, or has nothing to do. This has been found useful in rounding-up, for when the ram is once brought down to the right point to give the required diameter, the work has only to be regularly turned round. Of course all has to be dead tight, but there are no joints except cupped leather ones, and very few of those.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.
XXIII.—SOAP (*Continued*).

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

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(*Continued from page* 494.)

Our specifications for soap have been revised twice or three times, and need another revision in one or two particulars, which we will mention a little later. The specifications at present in force are as follows:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

SPECIFICATIONS FOR SOAP.

All soap will be bought by the pound. A shipment of toilet soap or common soap having been received, one cake or bar taken at random will be subjected to examination, and the shipment will be accepted or rejected on this sample cake or bar. The amount of soap to be paid for in a shipment of toilet and common soap will be determined by the amount of combined alkali or its equivalent in the shipment, and this will be determined by multiplying the amount of combined alkali in the sample cake or bar by the number of cakes or bars in the shipment, and dividing this product by the amount of combined alkali in a pound of soap as detailed below. The amount of detergent for cleaning paint and varnish in a shipment will be determined by the net weight of the material as received.

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona.

The articles will contain information which cannot be found elsewhere. No. I, in the Journal for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July and August numbers, on How to Design a Paint; No. XX, in the September number, on Disinfectants; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative; No. XXIII, in the November number—continued above—on Soap.

These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these Contributions to Practical Railroad Information of special value in indicating the true character of the materials they must use and buy.

Toilet Soap.

The material desired under this specification is a neutral soda soap, as free as possible from water, mineral matter, carbonated alkali and uncombined caustic alkali. It may contain glycerine and sugar, or may be free from them, and may be either transparent or opaque. The cakes should weigh about 4 ounces each. The shape of cake preferred is oval, about 3⅜ inches by 2⅜ inches, with edges about ½ inch thick, and the thickness of cake in the center about 1⅝ inches. The color preferred is somewhat lighter than that of Brown Windsor. The perfume should have the characteristic odor of Lavender, and should not add over five (5) cents per pound to the cost of the soap. It is desired to have the cakes stamped on one side with the initials of the Road to which the soap is furnished, and each wrapped in soft paper. The manufacturer may put his stamp on the opposite side of the cake.

In determining the amount of soap in a shipment, 630 grains of combined alkali, reckoned as soda [Na_2O], will be regarded as a pound of soap. Also in the glycerine or transparent soaps the glycerine and sugar will be paid for, each five (5) grains of glycerine and each twenty (20) grains of sugar being received in place of and regarded as the equivalent of one (1) grain of combined alkali. Transparent soaps which contain less than 500 grains of combined alkali, reckoned as soda [Na_2O], or more than 1,000 grains of glycerine or more than 700 grains of sugar per pound, are not desired.

Toilet soap will not be accepted which shows on analysis more than one-fourth of one per cent. of mineral matter or more than one-fourth of one per cent. of carbonated alkali, reckoned as carbonate of soda [Na_2Co_3], or more than one-half of one per cent. of uncombined caustic alkali, reckoned as caustic soda [NaOH], or more than one per cent. of common salt; nor if a cylinder of the soap ⅞ inch in diameter, and one inch high, cut from the center of the cake, fails to sustain a weight of 15 pounds for five minutes without crushing or compressing more than $\frac{1}{16}$ inch. Also Toilet Soaps made so largely of cocoanut oil, palm oil, palm-nut oil, or other fat of characteristic smell that they leave their peculiar odor on the hands, will not be accepted.

Common Soap.

The material desired under this specification is a neutral soda soap as free as possible from mineral matter, carbonated alkali, common salt, and uncombined caustic alkali. It should be carefully cut in bars weighing about a pound each.

In determining the amount of soap in a shipment, 525 grains of combined alkali, reckoned as soda [Na_2O], will be regarded as a pound of soap. No allowance is made for glycerine or sugar in this grade of soap.

Common soap will not be accepted which shows on analysis more than one-fourth of one per cent. of mineral matter, more than one-fourth of one per cent. of carbonated alkali, reckoned as carbonate of soda [Na_2Co_3], more than one-half of one per cent. of uncombined caustic alkali, reckoned as caustic soda [NaOH], or more than one per cent. of common salt, nor if a cylinder ⅞ in. in diameter and one inch long cut from the center of the bar when received fails to sustain a weight of five (5) lbs. for five (5) minutes without crushing or compressing more than $\frac{1}{16}$ in.

Detergent for Cleaning Paint and Varnish.

The material desired under this specification is a mixture of powdered soap and tripoli or pulverized pumice-stone. The proportions of the two ingredients desired are 70 per cent. tripoli or pulverized pumice-stone, and 30 per cent. soap. The tripoli or pumice-stone should be very fine and free from hard particles. The soap should be as free as possible from water, carbonated alkali, uncombined caustic alkali and common salt, and should be finely ground.

This material will not be accepted if the proportion of tripoli or pumice is less than 65 per cent. or more than 75 per cent., nor if it shows on analysis more than 0.10 per cent. of carbonated alkali reckoned as carbonate of soda [Na_2Co_3], more than 0.20 per cent. of uncombined caustic alkali reckoned as caustic soda [NaOH], more than 0.30 per cent. of common salt, more than 5 per cent. of water, or if it contains any other substances than soap and tripoli or pumice, nor if the tripoli or pumice is so coarse or contains such hard particles that it scratches the varnish.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., January 3, 1888.

With regard to the above specifications, it will be noted we do not buy soap by the cake, but rather by the pound, and that although the manufacturers possibly many times claim to make each cake weigh a pound, we do not accept this as final. It will also be noted that we really have placed our valuation of the soap on the amount of combined alkali that it contains. This is in accordance with the explanation given in the early part of this article, that it is really the alkali combined with the fat that we want for detergent, not the free alkali or the carbonated alkali, but the alkali combined with the fat. One difficulty has arisen in regard to this method of buying soap—namely, the bill cannot be paid until the chemical analysis is made. A number of other plans were tried, but nothing has been found that was as successful as this, and all the annoyance that now results is that parties may have to wait three or four days longer for their money. This has not thus far in practice proved a serious difficulty. One point further. It will be noted that the analysis on which the shipment is paid for, and, indeed, the whole transaction, is based on a single cake of soap selected at random from the shipment. If this single cake happens to be larger than the average of the shipment, the manufacturer gets pay for a little more soap than the shipment really contains. If the single cake happens to be a little smaller than the average of the shipment, the manufacturer does not get pay for quite as much soap as the shipment contains. It is believed that these things will equalize themselves in the long run, and as the requirements of our specifications are moderately strict, we have only found a few parties who were willing to take the pains necessary to make as good a soap as we desire, and consequently their orders have been moderately continuous.

One peculiar concomitant of this method of buying and paying for soap has resulted. Of course the manufacturers are desirous of selling as much soap as possible. If, now, they receive an order for 100 lbs. of soap, and send 100 bars, each of which contains combined alkali—a little less than enough to make a pound of soap—they will not sell as much soap as the order calls for. On the other hand, if each bar contains a little more combined alkali than the equivalent of a pound of soap, the manufacturer is paid for a little more soap than the order calls for. In general, a bar that weighs exactly one pound as the manufacturer ships it, will rarely contain quite as much combined alkali as is the equivalent of a pound of soap according to specifications, owing to the fact that much of the soap is sold soon after it is made, and contains rather more water than a well-seasoned soap should contain. We accordingly find that almost all the manufacturers who supply us with soap are cutting all the bars a little heavy, both, as said above, to counterbalance the water, which is a varying constituent, and also because they know they get paid for all the soap there is in the shipment, even though it may exceed the amount ordered. A parallel to this is found in the oil trade. Originally a barrel of oil contained 42 gallons, but as oil is usually bought by the barrel, the size of the barrel has gradually crept up until now very few barrels contain less than 50 gallons. So with the soaps. We have seen many bars of soap, which nominally weighed a pound, which did not weigh over 11, 12, or 13 ounces. The bars in our shipments now almost universally weigh over a pound. A little reflection will convince every one that the only fair way to buy soap is by the actual value given, and that the method which we have adopted is not only fair to the consumer, but also to the manufacturer.

The peculiarities of the specifications for toilet soap are, perhaps, sufficiently evident without much comment. The glycerine and sugar mentioned, as will be observed, are measured in value in terms of combined alkali. The ratios used were based on the relative commercial prices of the articles involved. It is in the matter of sugar and glycerine that our soap specifications need revision, and we will explain this a little later, when we come to describe the chemical methods of determining the different constituents. We have had little difficulty in getting soaps that were within the limits for mineral matter, for caustic alkali, and for free carbonated alkali, and common salt given in the specifications. Many times manufacturers who do not know accurately what they are doing find that their soaps do not fill our requirements, but it is

believed, after some six or eight years' experience, that the requirements are not excessively difficult. It will be observed that no limitation is placed on the manufacturers as to the kind of fat acid they shall use, except in the toilet soap, that those which leave a characteristic disagreeable odor on the hands shall be avoided. Otherwise than this the manufacturers can use any materials so long as they fill the requirements.

Upon this point it may be well to say that the physical test for hardness was devised as a simple means of controlling the kind of acids used. If the soap is made of all rosin, and shipped before it is dried out at all, it would not stand the physical test, and the same is true of a number of the other fats. In order to meet this difficulty, and at the same time not go into the question of specifying what kind of fats should be used, we devised the physical test, and it has served our purpose charmingly.

It will be observed that in the common soap the amount of combined alkali that is equivalent to a pound of soap is considerably less than toilet soap. This is due to the fact that in toilet soap there is much less water than in common soap. The ordinary common soap contains not far from one-third of its weight water, especially if the soap is fresh. Toilet soap generally does not contain more than 5.00 to 8.00 per cent. water. Due to this presence of water rendering the soap softer, the physical test is much less severe for toilet soap than for common soap. In the detergent for cleaning paint and varnish, the quality of the soap, so far as amount of free caustic and carbonated alkali are concerned, is the same as in the common soap, our idea being to limit the damage to the varnish, due to this constituent, as much as possible. We have had very little difficulty in getting this article in the market, although there is chance for some improvement in the manufacture. The material should be in the form of a powder, and as most of the shipments which we receive are a little lumpy, which we regard as objectionable, it is entirely possible that in the next issue of the specifications a proviso will be introduced to overcome this difficulty.

A circular giving directions for the use of detergent for *Cleaning Paint and Varnish* has been issued. The directions in this circular will undoubtedly be understood by what has preceded. The oil treatment recommended, following the use of the detergent, has been found to be quite valuable, so much so that a car properly cleaned with detergent, and gone over carefully with linseed-oil, looks almost as good as new, provided the varnish has not become cracked. The gloss is largely restored, and the inequalities of the surface are largely filled by this layer of oil. Of course if the varnished surface has become cracked nothing will restore this that we know of except revarnishing. The following in the circular:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

DIRECTIONS FOR USING DETERGENT FOR CLEANING PAINT AND VARNISH.

The ordinary common soap used in cleaning paint and varnish has a very destructive action on the varnish, dissolving it rapidly; a car cleaned two or three times with strong soap suds must be revarnished and in some cases repainted. To diminish this destructive action of the alkali in the soap, is the object of the detergent for cleaning paint and varnish. This detergent is a mixture of tripoli or pulverized pumice-stone with powdered soap, and its cleansing power comes from the slight solvent action of the soap and the scouring action of the tripoli or pumice-stone. The varnish or paint is destroyed to a certain extent by the detergent, but the destructive action is very much less than with soap suds. This material should be used in accordance with the following:

Directions.

Go over the surface to be cleaned with a wet sponge, piece of waste or cloth, which has been dipped in the dry detergent. Use plenty of the material but not much water, and rub until the dirt is detached from the surfaces. Wash thoroughly with clean water, using sponge, hose, or soft washing brush. Allow the surface to become dry and then give it a light coat of raw linseed-oil, using a piece of waste or a cloth; what is known as rubbing oil may be used also for the purpose; care should be taken to leave only a very thin layer on the surface. The oil replaces much of the paint or varnish which has been removed by the detergent.

The oily waste or rags should be disposed of with great care, as they are quite liable to take fire from spontaneous combustion. They should never be left in the cars, thrown on the ground or floor, or put away with the cleaning utensils; when practicable they should be burned.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., March 16, 1888.

The chemistry required in our specifications presents some problems of considerable interest, and we have put a good deal of study on this subject, and are inclined to think that at least our method of determining caustic alkali in soaps is not in common use. Indeed, we may go a step farther, and say we do not know of any other method which will give the free caustic alkali in a soap except the one which we use. We determine in soaps the excess of caustic alkali, the carbonated alkali, the combined alkali, the mineral matter, the common salt, make physical test, and weigh the cake. The reasons for the weight of the cake, the physical test, and the method of making the physical test are sufficiently clear from the specifications.

The common salt is determined by decomposing a weighed sample of the soap with dilute sulphuric acid, sometimes with the addition of a little oil to dissolve the separated fat acid, in order to facilitate decomposition. After the decomposition is complete the beaker is chilled, and the fat acids become a cake. They are then removed and washed. If it is desired to be strictly accurate, a second melting of these fat acids with distilled water, so as to secure complete removal of every trace of common salt from the cake, is made use of. The solution containing the common salt is filtered and then neutralized with carbonate of soda, and then titrated with standard nitrate of silver solution, using neutral chromate of potash as the indicator.

The mineral matter and the carbonated alkali are determined in one operation. A weighed amount, five grammes of the soap, is dissolved in alcohol. If we desire to be strictly accurate in our carbonate of soda determination, we use absolute alcohol, since carbonate of soda is slightly soluble even in 95-per cent. alcohol. For common purposes, however, ordinary 95-per cent. alcohol does very well. The soap dissolves readily, especially under the influence of heat. As soon as solution is complete, it is filtered through paper or in a Gooch crucible and washed with alcohol. The carbonate of soda and the mineral matter remain on the filter. When washing is complete, the carbonate of soda is dissolved from the filter by means of water, and is subsequently determined by the well-known methods of alkalimetry, using phenolphtaline for the indicator. The mineral matter remains on the filter, and is determined by ignition of the filter or drying with Gooch crucible, and weighing in the ordinary way.

If silicate of soda is a constituent of the soap, our experience indicates that quite a large portion of this will appear in the caustic alkali determination, which will now be described, and will render the amount of that constituent so high, that the soap would be rejected on account of caustic alkali. It also shows a tendency to break up in the alcohol solution used in determining the carbonate of soda and mineral matter, as above described, so that we are inclined to think we catch this element in one of these two places. If not, it would, of course, appear later in the determination of the combined alkali.

The excess of caustic alkali in soap is determined as follows: A standard solution of stearic acid in alcohol is prepared and its titer accurately determined. The solution that we use contains about seven and a half grammes of stearic acid to the liter of alcohol. The absolute amount is not essential, but the titer, in terms of the standard alkali, must, of course, be known. Five grammes of the soap to be tested are then placed in a small flask, and 100 cubic centimeters of the stearic acid solution added, and the vessel placed on the steam table or sand bath. Solution gradually takes place, the soap dissolving in the alcohol, and the caustic alkali, as fast as it appears,

combining with the stearic acid in the solution. We also find that under the influence of the heat necessary to produce solution, the carbonate of soda in the soap, if there is any, is slowly dissolved, and if the amount is very small it may completely disappear. We are not quite sure whether this decomposition of the carbonate is due to the fact that we commonly use 95-per cent. alcohol in making the stearic acid solution, or whether the boiling stearic acid solution decomposes carbonate of soda. Whatever the explanation, the fact remains. When solution is complete the liquid is filtered through paper in the ordinary way, and any mineral matter, together with the carbonate of soda not decomposed, is left on the filter. The solution containing the soap and stearic acid is then titered with standard alkali, using phenolphtaline as indicator. The difference between the titer of the 100 cubic centimeters of the stearic acid solution which were started with and that obtained at the end of the operation represents the free caustic alkali together with a part of the carbonate of soda. The remaining part of the carbonate of soda on the filter is obtained in exactly the same way as above described—namely, by the well-known methods of alkalimetry, using phenolphtaline as the indicator. The sum of the caustic and carbonate of soda obtained by these two determinations represents the total of these two constituents present in the soap. The previous determination has, however, given us as accurately as possible the carbonate, and the sum above obtained diminished by the amount of carbonate shows the amount of free caustic alkali in the soap. We do not, of course, reduce the results obtained by the use of the standard solutions to percentages and then subtract the carbonate from the sum of the caustic and carbonate. The actual operation is done in cubic centimeters of the standard solutions. The final results are, of course, calculated to percentages. Duplicate results with this method are extremely close, and, as stated above, we do not know of any other method of getting at the amount of free caustic alkali in a soap better than the one which we use. Of course this problem has been studied a good deal. We have used this method now for some three or four years, and this is the first time that it has been published. It is obvious that there may be three conditions of the soap to be examined.

First, there may be an excess of free caustic alkali along with a neutral soap. It is quite probable that the common method—namely, of dissolving the soap in alcohol and titrating with any standard acid, using phenolphtaline as the indicator, would give the amount of free caustic alkali under this condition. Our own method is likewise, we think, equally reliable.

The second case would be when there is free caustic alkali and free fat—that is, the operation of saponification was not quite completed in the boiling. In this case the ordinary method of dissolving in alcohol fails entirely, since during the solution the free alkali combines with the free fat, and therefore does not appear as it should. In this case our own method gives likewise, we think, and accurately the free alkali, since the free alkali combines with the stearic acid rather than with the unsaponified fat.

The third case would be where there is a deficiency of alkali that is not enough to saponify all the fat. If the excess of fat is unsaponified material, our method would show nothing. If, as happens in many cases, the excess of fat is free fat acid, we always get this by our method.

We have studied soaps and have used analytical methods for the sake of protecting the interests committed to our charge, and accordingly we have not put much study on the material from the soapmakers' standpoint. We have never tried to develop a method which under all circumstances would tell whether there was an excess of fat. This is a problem for the soapmakers rather than for ourselves, since the excess of fat causes us no injury.

The method used in determining the combined alkali depends something on what the previous tests have shown. If there is mineral matter, especially carbonate of lime, or other substances which under the influence of heat would either be alkaline or combined with the soda, we take the sample from which we have removed the mineral matter and carbonate of soda as previously described, and evaporate and burn until all the organic matter is gone. In case no mineral matter is present, five grammes of the soap is put in a platinum dish and the organic matter burned. At the last we usually add a little pulverized chlorate of potash, to assist in removing the last traces of carbonaceous matter, and also to oxidize any sulphides which may be present, and which are formed by the deoxidation of a trace of sulphate which may exist as impurity in the soap. It is obvious that in the first case all the alkali that was in the soap originally as combined alkali and caustic alkali is now in the platinum dish. In the second case all the combined, caustic, and carbonated alkali that was in the soap are now in the platinum dish. These are dissolved in water and determined by the well-known methods of alkalimetry. A deduction for the caustic in the first case, and for the caustic and carbonate in the second case shows the combined alkali. The whole operation of making all the determinations requisite for examining a soap need not take over one-half a day, and a good deal of the time, as would naturally be supposed, would be taken up in obtaining the solutions. Of course in a well-regulated laboratory other work is done while the solution is going on.

In addition to the above determinations it will be noted that we state that the sugar and glycerine in these kinds of soap will be paid for, and this, of course, involves a determination of these constituents. It is in regard to these two that our specifications, we think, need revision, since we find by actual experience that we have not yet been able to get a satisfactory method for the determination of the sugar and glycerine. We have experimented a good deal with the Benedikt-Zsigmondy method for the determination of glycerine, by converting the glycerine into oxalic acid, but have not always succeeded in getting satisfactory results with it. As soon as we obtain a satisfactory method for the determination of glycerine, it is probable we will revise our specifications, and require a small percentage of glycerine as an essential constituent of all our toilet soaps. Of course the sugar is previously separated from the glycerine, and is subjected to a separate determination. At present we are not encouraging the purchase of glycerine soaps, for the reason that we do not feel satisfied with our method of determining this constituent.

In the next article we will try to treat the subject of Steel for Springs quite at length.

(TO BE CONTINUED.)

ROLLING FLUID METAL.

IN a paper read recently before the Iron and Steel Institute, Sir Henry Bessemer described his early attempts to roll sheets of steel from molten metal, the partial success which he had attained, and the apparatus which he had then patented. After this historical prelude, he continued as follows:

Having thus freely criticised my first imperfect form of apparatus, I will proceed to explain in what manner I now propose to remedy these defects. These suggested improvements will be readily understood by reference to figs. 1, 2 and 3, annexed; and here I beg to observe that I have not gone into the many details necessary for the construction of rolling mills of this description, but have merely given such an illustration of the general scope of my proposals as will enable them to be understood.

The rolls *L* and *M* consist of two hollow drums through which a tubular steel axis *N N* passes, and conveys a plentiful supply of water for keeping the rolls cool.

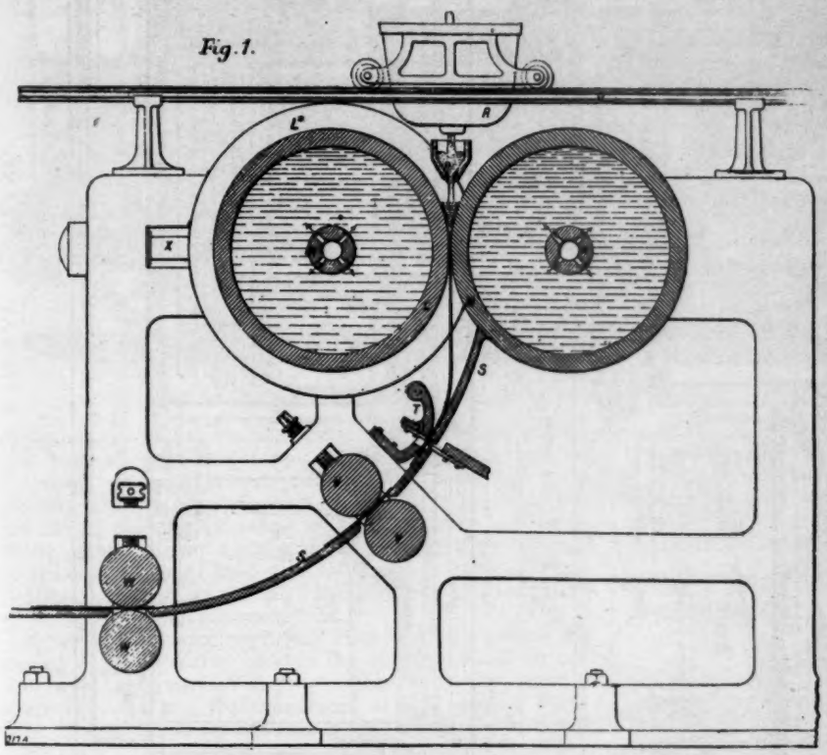
The brasses which support the roll *M* are fixed, while those which support the roll *L* are movable in a suitable slide, and are pressed on by a small hydraulic ram *X*, which is in free and uninterrupted communication with an accumulator, so that at any time should the feed of metal be in excess, the roll *L* will move back and prevent any undue strain in the machinery, the only result being a slightly increased thickness at that part of the sheet of metal, a defect which, as it extends parallel across the

whole width of the sheet, will be easily corrected in the next rolling operation.

The rolls, by preference, may be made 3 ft. or 4 ft. in diameter, each having a flange on one end only, and thus form a trough with closed ends for containing the fluid metal.

In order to obtain a regular and quiet supply of metal, I employ a small iron box or reservoir *P*, lined with plumbago or fireclay, along the bottom of this reservoir. Some 10 or 20 small holes of about ¼ in. in diameter are neatly molded by a row of conical brass pegs. The reservoir is provided with a long bar or handle at each end. By means of these bars, the reservoir is supported on the side frames, the bars falling into suitable notches made in the roll frame for that purpose.

Fig. 1.



ROLLING SHEETS FROM LIQUID METAL.

And here I would observe that the reservoir *P* should be well dried, and its interior surface heated to redness prior to its use. For this purpose a small furnace or stove should be placed near to the rolls, the stove having two or three rectangular openings on its upper side, in size corresponding to the interior of the reservoirs, which are to be inverted over these openings, the hot products of combustion passing freely through the row of holes, and bringing up the interior surface of the reservoir to a full red heat. In this state the reservoir is to be placed in its proper position in the roll frame, immediately after the arrival there of the ladleful of fluid metal.

A pair of rails *Q* are supported on the roll frames and serve for the conveyance of the ladle *R*, which is mounted on wheels and brings the metal direct to the rolls, or to any number of pairs of rolls that may be placed in line.

The ladle is provided with one or more valves or stoppers of the usual kind, by means of which the supply of metal to the reservoir *P* may be easily regulated; the several small streams from the reservoir will deliver an almost constant quantity of metal, varying only slightly as the operator regulates the head of metal in the reservoir—a means of regulating which a little experience would allow him to utilize with great advantage; from the smallness of the head of metal in the reservoir the several streams will fall quietly without splashing. These streams do not fall direct on to the rolls, but into a small pool formed between the thin films solidifying against the cold surface of the rolls, the metal at all times being free from floating slags.

The speed of the rolls also affords a means of regulating the quantity of metal retained between them; and as a pair of 4-ft. rolls would only require to make about four revolutions per minute, a quick-running engine could easily be provided with differential speed-gearing, so as instantly to alter the speed of the rolls to the very small extent ever required during the rolling process.

The thin sheet of metal, as it emerges from the underside of the rolls, is received between the curved guide plates *S* and *T*, to the latter of which a cutting blade *U* is bolted. Beneath the guide plate *S* a similar cutting blade is arranged to suddenly move forward by a cam and cut the thin sheet in two, the piece so cut afterward passing between the second pair of rolls *V V*, from which it again descends by gravity, and passes between the third pair of rolls *W W*, and is delivered on to a horizontal table, or it may be allowed to slide down the inclined end of a cistern of water, and moved slowly forward. By these means it will be possible to cool and stack a ton of plates without any labor or trouble.

The thickness of plates capable of being produced will much depend on the size of the rolls; if drums of 10 ft. or 12 ft. in diameter are employed, it is probable that plates of ¼ in. in thickness could be produced, or even thicker. The central space between drums of such large diameter would represent a sort of plate ingot mold with nearly parallel sides for some 8 in. or 10 in. in depth.

When producing sheets of steel, the initial thickness of which does not exceed $\frac{1}{10}$ in., it might at first sight appear that the finished plate, with only two more rollings, would not get sufficient work done upon it to develop the same degree of toughness and cohesion that would be obtained by the many rollings which the present system necessarily involves; but a little consideration will render apparent the entirely different conditions under which the formation of the plates takes place.

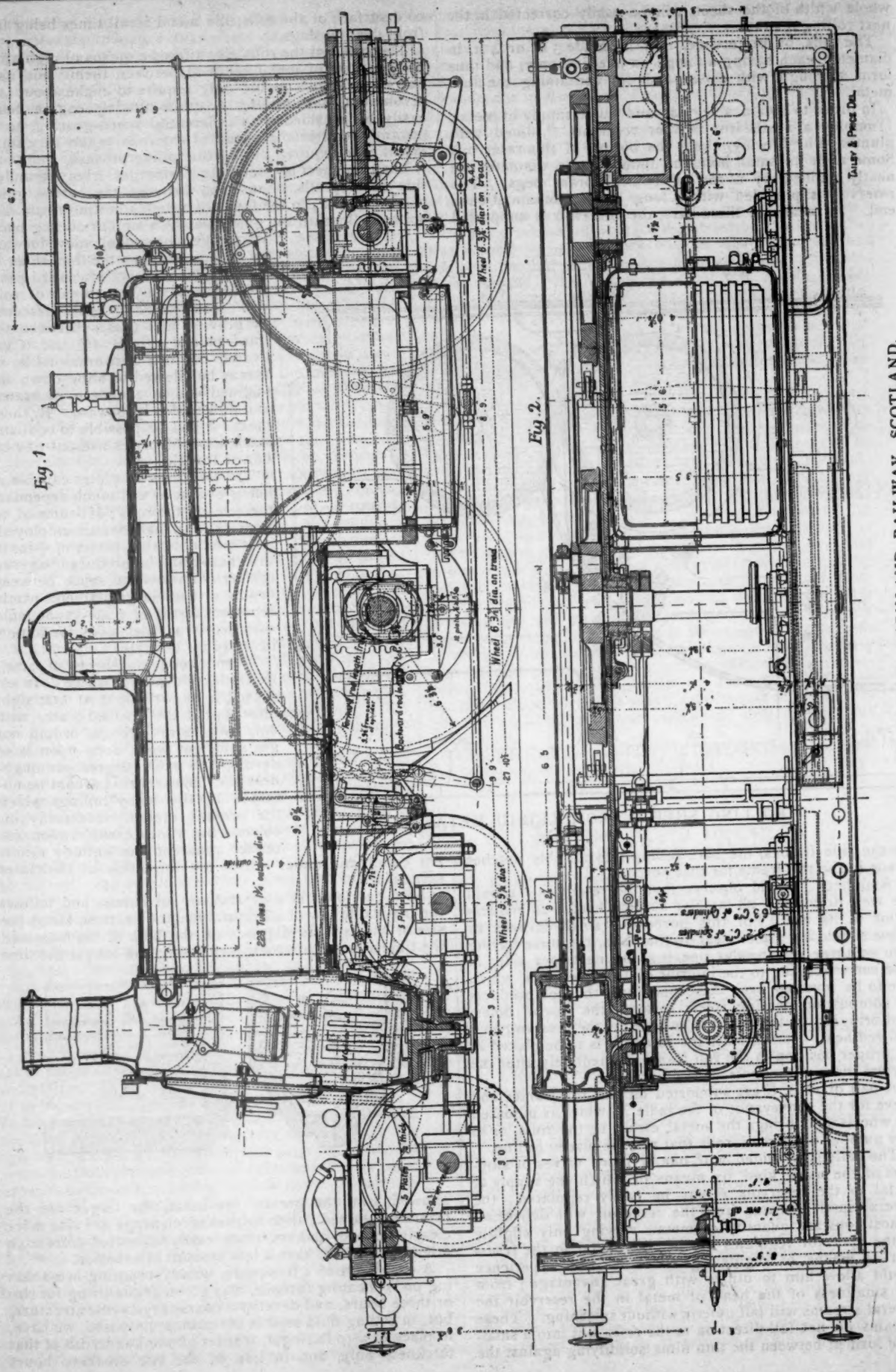
Mild cast steel is a crystalline substance, and follows the inevitable law of all crystalline bodies, in so far as the size of the crystals depends on the bulk of the mass and the time allowed for their formation; the longer the time

Fig. 2.

Fig. 3.

allowed, and the greater the mass, the larger are the crystals obtained; their planes of cleavage are also more clearly defined, and are more easily separated from each other, or, in fact, have a less amount of cohesion.

A cast ingot of 1 ft. square, quietly reposing in a soaking pit or heating furnace, may go on crystallizing for two or three hours, and develop a coarse crystalline structure, but, in rolling fluid steel in the manner proposed, we have, in place of a 10-in. ingot, a sheet of one-hundredth of that thickness only, and in lieu of the two or three hours



STANDARD PASSENGER LOCOMOTIVE, HIGHLAND RAILWAY, SCOTLAND.

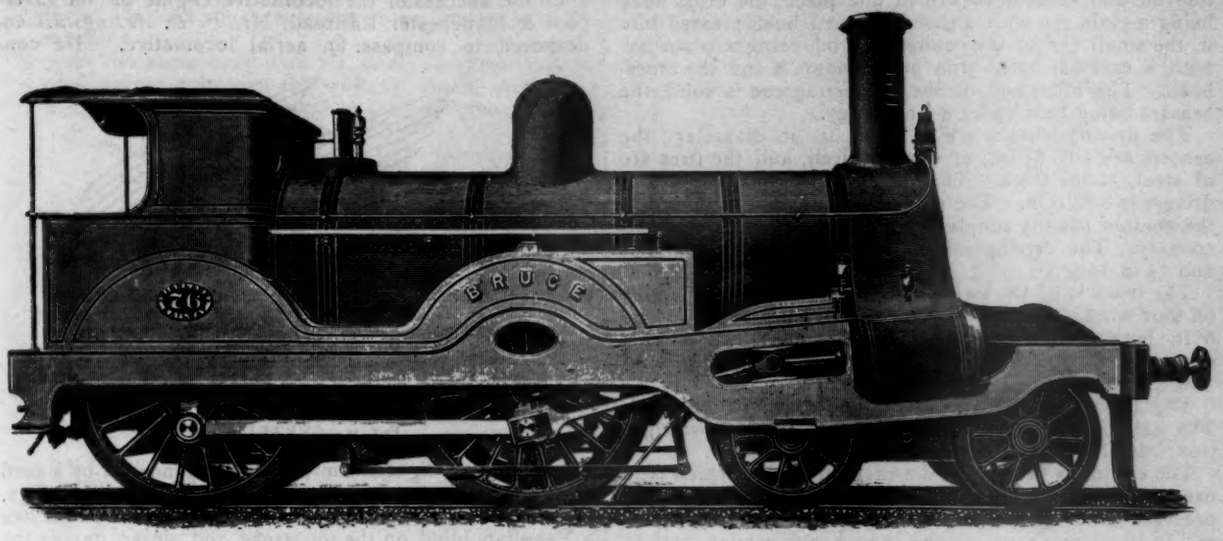
allowed in ordinary cases for the development of crystals, we have, when using a 4-ft. pair of rolls, making four revolutions per minute, a transition from absolute fluidity to absolute solidity in just one-half of a second of time, in a mass of only $\frac{1}{10}$ in. in thickness; and if crystals are developed at any period during the half second of time occupied by this transition, they must be microscopic indeed, and possess but little if any of the properties that are developed in large masses during hours of repose in the soaking pits; hence it appears to me highly probable that the homogeneous fluid metal will pass at once into a perfectly homogeneous uncrystalline body, and being subjected to fluid, semi-fluid and solid pressure in rapid succession, will develop the full cohesive force and toughness of which the metal is susceptible.

It will be at once perceived that in this mode of disposing of a ladleful of steel in the rolls we avoid the cost and wear and tear of casting molds, and the labor of their removal and rearrangement at each casting operation, also the need for soaking pits or reheating furnaces, with their accompanying cost of labor and fuel. There will also be no loss arising from the waste ends of piped ingots, etc.

It will be understood that thin sheets so produced will not acquire any scale during the single minute they are exposed to the oxidizing influence of the atmosphere prior to their immersion in the water-tank, and in consequence of there being no overlapping of plates in rolling there will be but little loss of metal in shearing.

With reference to the speed of production, let us assume the mill to be fitted with a pair of 4-ft. diameter rolls, 18 in. wide, and making four revolutions per minute, and set to produce a sheet having an initial thickness of $\frac{1}{10}$ in., and rolled by the third pair to $\frac{1}{20}$ in., we should thus have a surface velocity of the first pair of rolls equal to 50 ft. per minute; and making when finished 100 plates 18 in. by 12 in., $\frac{1}{20}$ in. thick, and weighing 300 lbs., or equal to a production of one ton of plates in $7\frac{1}{2}$ minutes.

Hence it becomes a question which is the least costly mode of dealing with a ladleful of fluid steel?—forming it into massive ingots in molds, or making it into thin sheets in the manner proposed.

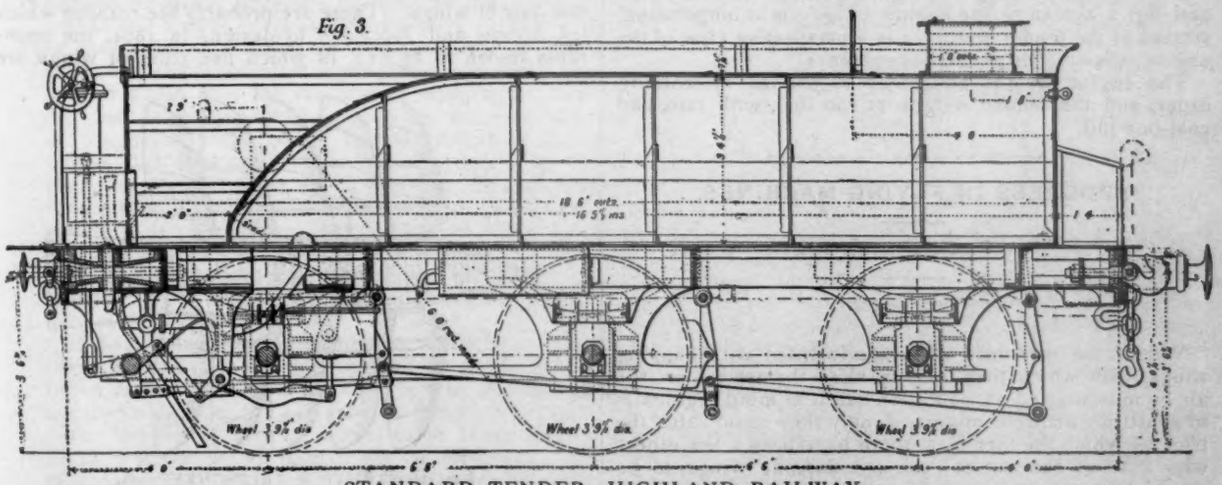


PASSENGER LOCOMOTIVE FOR THE HIGHLAND RAILWAY, SCOTLAND.

PASSENGER LOCOMOTIVE FOR THE HIGHLAND RAILWAY.

THE accompanying illustrations, from the London *Engineering*, show the standard passenger engine of the Highland Railway in Scotland. This road runs through a rough and hilly country and has many heavy grades, in one place rising 66 ft. to the mile for 17 miles in succession. The traffic is variable, being heavy in summer and very light in winter; but in the winter there is much delay from snow.

Fig. 3.



STANDARD TENDER, HIGHLAND RAILWAY.

The engine is of the eight-wheel type, with four driving-wheels and a four-wheeled truck. The cylinders are outside, with the steam-chests inside, and are placed on an incline of 1 in 12. The cylinders are 18 in. in diameter and 24 in. stroke. The steam ports are 15 × 1¼ in. and

the exhaust ports 15 × 3 in. The valves have 4 in. extreme travel and 1 in. outside lap. The valve motion is of the Allan straight-link type. Valves, eccentrics and eccentric straps are of cast iron. The slide-bars are of iron, case-hardened, and the slide-blocks are cast iron with a large surface, 72½ sq. in. on each block. The piston-rod and cross-head are in one piece, the cross-head being a plain eye with a case-hardened bush pressed into it, the small end of the connecting-rod being a plain jaw with a case-hardened iron pin through it and the cross-head. The other end of the connecting-rod is solid, the brasses being held up by a single key.

The driving-wheels are 6 ft. 3½ in. in diameter; the centers are 5 ft. 8½ in., of wrought iron, and the tires are of steel, 3½ in. thick. The distance between centers of drivers is 8 ft. 9 in. The driving springs are equalized in the manner usually adopted on eight-wheel engines in this country. The driving-axle journals are 8 in. in diameter and 7½ in. long.

The truck is of the swing-bolster pattern and is carried on four wheels 44½ in. in diameter, the axles being spaced 6 ft. between centers. The wheel centers are of cast steel and are 39½ in. in diameter, the tires being of steel 3 in. thick.

The frames are of the plate type usual in England. The axle-box guides are of steel, with liners of wrought iron, case-hardened. The axle-boxes are of steel.

The engine is fitted with the vacuum brake, which is in use on this road. In addition it has the Chatelier counter-pressure water brake, which is found to work very well and to be of much use on the long heavy grades, both in holding the train and in keeping the cylinders and valves moist when steam is shut off.

The boiler barrel is 50 in. in diameter and 9 ft. 9½ in. long. It is of ½-in. steel and double riveted throughout. The outside fire-box casing is 6 ft. 2½ in. long and 4 ft. 3⅜ in. wide. The tubes are 1¾ in. in diameter and 10 ft. 4 in. long. The fire-box is of copper and is 66 in. long and 41 in. wide inside. The grate area is 18.8 sq. ft.; the heating surface is: Fire-box, 97.5; tubes, 1,038.5; total, 1,136 sq. ft. The boiler is fed by two Gresham automatic injectors.

The tender tank holds 2,250 gallons of water. The tender has an iron frame and is carried on six 45½-in. wheels, of the same pattern as the engine truck wheels. The tender axles have both outside and inside bearings. The tender wheel base is 13 ft.

In the accompanying cuts fig. 1 is a longitudinal section and fig. 2 a plan of the engine. Fig. 3 is a longitudinal section of the tender and fig. 4 is a perspective view of the engine, showing its general appearance.

The engine weighs altogether 96,320 lbs. in working order, and the tender weighs 71,680 lbs., with tank and coal-box full.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page 511.*)

While the inventors who experimented with flapping wings, with which they tried to raise themselves on the air by muscular effort, doubtless had it in mind eventually to substitute artificial motors, if only they could catch the trick by which the bird flies, there have been a few others who have at the outset designed flapping wings, to be moved by some primary artificial motor. As they generally knew of no such motor, within admissible limits of weight in proportion to its energy, such designs have remained mere projects, and but few experiments have been made.

The proposal of *Gérard*, in 1784, shown in fig. 12, seems to have been among the first. It apparently provides, in addition to the body and wings, for a steering arrangement in front, and for feet with springs to land upon. The inventor omitted to state in his printed description what motive power he intended to use, but an inspection of the drawing suggests the conjecture that the apparatus was to be propelled in part by escaping gases, like a rocket, and in part by flapping the wings through the medium of a gunpowder engine; proposals and experiments with such motors antedating, as is well known, those with the steam-engine. Be this as it may, soon after the success of the locomotive engine on the Liverpool & Manchester Railroad, Mr. *F. D. Artingstall* endeavored to compass an aerial locomotive. He con-

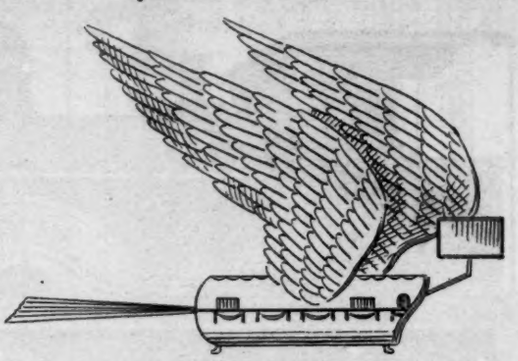


Fig. 12.—GÉRARD—1784.

structed a very light steam-engine, suspended it by a cord from the ceiling, and to the piston-rod he attached wings, which were so constructed that they opened somewhat like a Venetian blind on the up stroke and closed during the down stroke, moving through an arc of 80°. When steam was turned on the wings worked vigorously, but the machine jerked up and down, rushed from side to side, and, in fact, performed all kinds of gymnastic movements except flight. This experiment was terminated by the explosion of the boiler, and a second attempt, in which it was intended to use four wings instead of two, in order to keep up a continuous buoyancy, resulted in a second explosion; after which the experiments were abandoned. In 1868 Mr. *Artingstall*, in a communication to the Aeronautical Society of Great Britain, stated the weak point in his various experiments to have been the lack of suitable equilibrium.

Every experimenter with aerial apparatus has doubtless encountered the difficulty of obtaining in a machine that equilibrium which the bird maintains by instinct, and also of deriving continuous support from the flapping of one pair of wings. These are probably the reasons which led *Struvé* and *Telescheff* to design, in 1864, the apparatus shown in fig. 13, in which five pairs of wings are

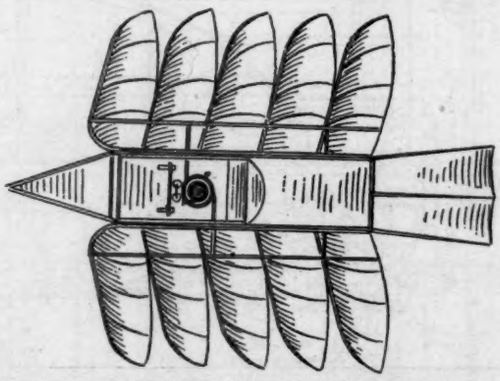


Fig. 13.—STRUVÉ & TELESCHEFF—1864.

attached to a central plane. The only description accessible to the writer states that the wings were moved by human force acting upon a spring, but it is evident that the apparatus was intended to be driven by artificial power, if the designers could only find one sufficiently light for that purpose. That they did not succeed in this seems to be a fair inference from the fact that the machine was not tested by experiment.

At the Exhibition of 1868, of the Aeronautical Society of Great Britain, Mr. *I. Palmer* exhibited a pair of wings

(to be driven by power) attached to a rotating axle, and so arranged that they expanded in the descent and closed in the ascent, like the action of a duck's foot in swimming; this motion being obtained in a remarkably simple manner by a roller running on an eccentric cam, which could be instantaneously changed in position, so as to convert the vertical lifting power into one of horizontal force. It does not seem to have been applied to any flying machine.

At the same exhibition Mr. *I. M. Kaufmann*, engineer of Glasgow, exhibited the working model represented in fig. 14, which was intended as the precursor of an aerial

FIG. 14.—KAUFMANN—1867.

steam machine weighing 7,000 or 8,000 lbs. The apparatus consisted of a steam boiler and engine, mounted upon wheels, and propelled by two long wings, which, during the down stroke, were set at an inclined direction backward, and were caused to turn at a forward angle during the up stroke. The main portion of the weight was to be sustained by superposed aeroplanes, and hence the machine should perhaps be described under that head, but it is here included under the head of wings, because of the mode of propulsion. The model weighed 42 lbs., and during the experiments with it its boiler, owing to its small size, was not fired, steam being supplied from an independent boiler. With steam pressure at 150 lbs. to the inch, the wings made a short series of furious flaps, and one of them suddenly gave way about 2 ft. from its base, upon which the other one failed also. The inventor stated that he was then engaged in the construction of a larger machine on the same principle, but since then nothing more has been heard of it. He proposed to secure stability by letting down or raising up a long "pendule" with telescopic joints, so as to adjust the center of gravity and keep the machine in a horizontal position, but it may well be doubted whether this would have proved effective.

At a meeting of the British Aeronautical Society, in 1871, Mr. *R. C. Jay* exhibited a model to illustrate a method which he proposed in order to use wings of any length and weight without loss of power. This consisted of two pairs of oscillating wings moving on the same shaft. It was expected that the forces generated by their motion would hold the machine is equilibrium, and that one pair of wings would be aided by the current of air, or whirlpool, produced by the movement of the other pair. This does not seem to have answered, for in 1877 the same inventor presented a model to the same society, illustrating a method of obtaining a figure of 8 or sculling action with one pair of wings, but at the same time Mr. *Jay* candidly stated that "although he had made a great many experiments, he had not yet succeeded in making a propeller (wings) sufficiently simple and effective for practical purposes."

It is said that about the same time an *optician* of Leipsic made a small steam bird, mounted on a globular steam boiler and actuated by a cylinder of 2 in. stroke, working wings 32 in. long. This machine would rise vertically 3 ft., the wings making about three beats during the flight, but the boiler limited the performance. It contained spirits of wine only sufficient for 38 seconds, and the apparatus was but a toy.

In 1871 *Prigent* designed the apparatus shown in fig. 15, which was evidently suggested by the dragon-fly; this is a favorite idea with aviators, who, as we have seen already, have proposed the combination of two pairs of wings over and over again. It was intended to be driven by steam, but although in that same year *Moy* had produced a steam-engine and boiler weighing but 27 lbs. per horse power, and *Stringfellow*, in 1868, has shown one claimed to weigh but 13 lbs. per horse power (both applied to aeroplanes), no attempt seems to have been made to experiment with *Prigent's* device. The fact is, that even the weight of the engines mentioned was too great, for it did not include the fuel and water, which for a non-con-

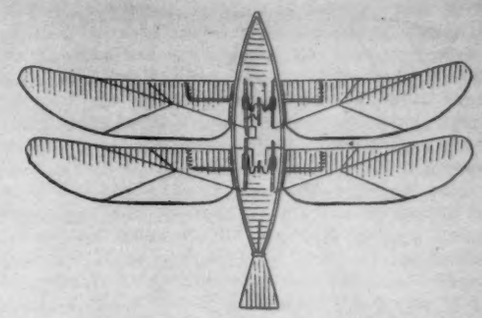


FIG. 15.—PRIGENT—1871.

densing steam-engine would amount to about 26 lbs. more horse power *per hour*, and this did not compare favorably with the motive power of birds. The pigeon, for instance, is known, both by dynamometric experiment and computation, to develop in ordinary flight from 160 to 425 foot-pounds of energy per minute for each pound of his weight, and as his pectoral muscles, which constitute *his* engine, generally compose $\frac{1}{13}$ of his weight, we have for the weight of *his* motor from

$$\frac{33.000 \times 10}{425 \times 43} = 18 \text{ lbs. to } \frac{33.000 \times 10}{160 \times 43} = 48 \text{ lbs.}$$

per horse power developed, including the fuel which enables him to fly for 10 to 12 hours at a stretch.

Hopeless, therefore, of accomplishing anything practical with steam-engines, experimenters with wings next turned their attention to springs or reservoirs of energy of various kinds, and with these they have succeeded in devising a number of toys which fly creditably for a few seconds. Clock springs were first tried, but they were

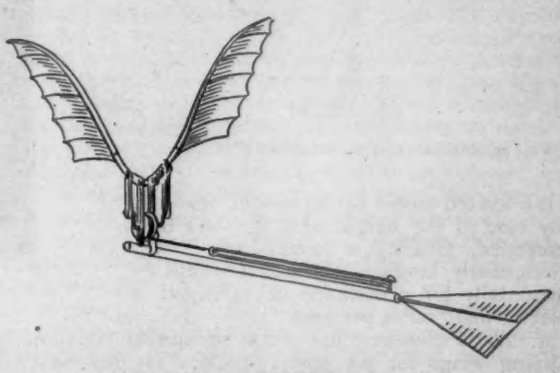


FIG. 16.—JOBERT—1871.

found to be unduly heavy, and in 1871 *Jobert* brought out his first mechanical bird, shown in fig. 16, driven by india-rubber in tension. The wings were arranged so as to change their plane automatically while flapping, in order to imitate the flexions of the natural wings, and the equilibrium was secured by adjusting the center of gravity so as to correspond with the center of pressure due to the angle of flight.

In 1872 *Pénaud*, who had already succeeded (1870 and 1871) in compassing flight with the superposed screws and with the aeroplane, which will be noticed hereafter, by the force of twisted rubber, applied the same motor to a mechanical bird, which is shown in fig. 17. The wings beat straight down, and the propulsion is obtained from the flexion of their outer edges produced by the reaction of the air. The bird is unable to rise from the ground, but upon being thrown off the hand it first descends some 2 ft., and then, having acquired the initial velocity needed for support, it flies for a distance of 50 ft. in 7 seconds, rising at the same time about 8 or 9 ft. above the point of departure, the equilibrium being perfectly maintained by the tail.

Simultaneously with this M. *Hureau de Villeneuve*, the permanent Secretary of the French Aeronautical Society, brought out his mechanical bird, which is shown in fig. 18. In this the plane of the wings is inclined at an angle

FIG. 17.—PÉNAUD—1872.

of 45°, and the power is obtained from twisted rubber. In consequence of the peculiar motion of the wings, this model was able to start direct from the ground, but owing

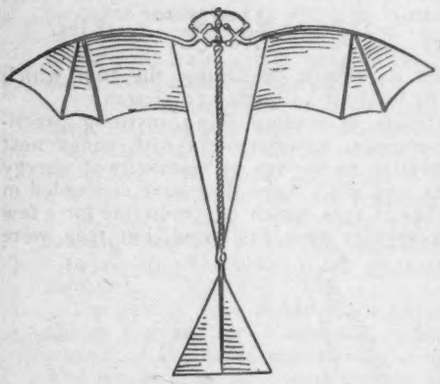


FIG. 18.—HUREAU DE VILLENEUVE—1872.

to the limited power of the rubber spring it only rose to the height of 4 ft., and then descended, forming a parachute. It was subsequently modified so that it would fly horizontally for a distance of 24 ft., at a velocity of 20 miles per hour.

M. *De Villeneuve* has been promoting aviation by flapping wings for the past 25 years. He has, first and last, designed something like 300 experimental models, so that his garret is a complete aviary of artificial birds. He built, some years ago, a huge steam bird on the model of a bat. Being aware that there was at that time no sufficiently light and reliable steam-engine with its boiler to furnish the power required, he placed only the engine on the bird, and connected it by a hose with a boiler on the ground. Upon trial, as soon as the steam was turned on the wings beat violently, and the apparatus rose with the inventor aboard. He grew nervous for fear that he would get beyond the length of his hose, and shut off steam suddenly, upon which the bird fell and smashed one of its wings. It is still in existence, and the inventor is awaiting the development of a very light motor in order to resume his experiments with this great bird, which is some 50 ft. across.

In 1872 M. *Jobert* brought out his second mechanical bird, shown in fig. 19. This is driven by twisted rubber, as being more manageable than rubber in tension, and consists of four wings beating alternately in pairs—as a horse trots—in order to produce continuous and uniform support and equilibrium, instead of the jerking motion observable in other apparatus. This flew fairly well, but a measurement of the foot-pounds developed and of the results obtained, in this as well as in the three other mechanical birds previously described, led to the inference that there was great waste of power, as compared with that of birds. This was attributed to the rigidity of the

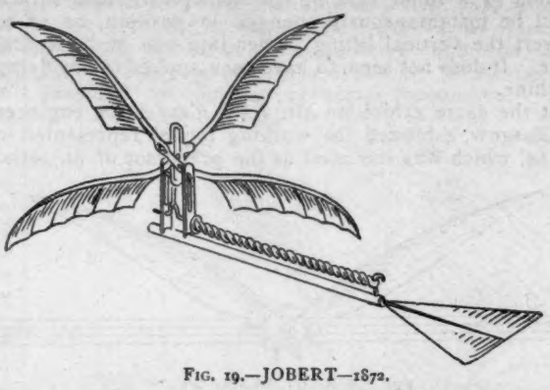


FIG. 19.—JOBERT—1872.

front edge of the wings in all these models, and accordingly in 1876 *Tatin* took the problem up again and succeeded, by a double eccentric working two levers connected to the front edge of the wing, in giving it a twist-

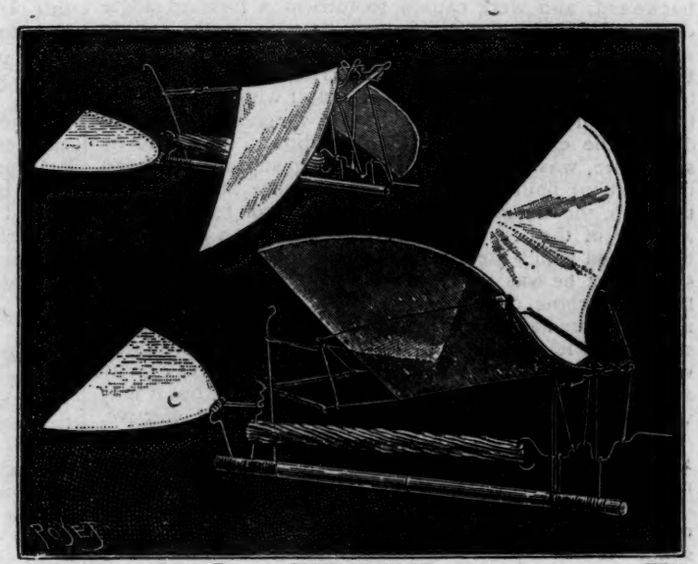


FIG. 20.—PICHANCOURT—1889.

ing motion similar to that of the bird. His apparatus flew some 65 ft., with rather less weight of rubber.

In 1889 *Pichancourt* carried the matter still further in the mechanical bird shown in fig. 20, in which there is a triple eccentric, each one actuating a lever fastened to a different point in the wings. His larger models, measuring 17½ in. from tip to tip of wings, and weighing 1½ oz., are said to have flown up to a height of 25 ft. and to a distance of 70 ft. against a slightly adverse wind.

Now here ar- no less than six artificial birds, each with a somewhat different wing-motion, and they all fly, when urged by the energy stored in twisted rubber. The question, therefore, occurs why practicable machines, to carry passengers, cannot be built by substituting some prime mover for the rubber; and the answer is that all these models are so wasteful of power that there is no motor known sufficiently light, in proportion to its energy, to take the place of the rubber. The best that seems to have been done with the latter was to obtain a flight of 7 seconds with flapping wings, and with the expenditure of energy at the rate of 600 foot-pounds per pound of twisted rubber. As there are 550 foot-pounds per second in a horse power, a primary motor, *with its supplies*, should in the same proportion weigh no more than:

$$\frac{600}{7 \times 550} = 6.4 \text{ lbs. per horse power,}$$

and there are none such known in practical operation.

Undeterred by this disheartening fact, M. *De Louvrié* designed, in 1877, the apparatus shown in fig. 21, which he calls the "Anthropornis," and which consists of a pair of wings, resembling those of the swallow, fastened to a hull mounted upon wheels, and intended to be actuated by a steam-engine or a petroleum motor. A spring is to contribute to the downward stroke, and is to be raised by the motor on the up stroke. M. *De Louvrié* is a veteran

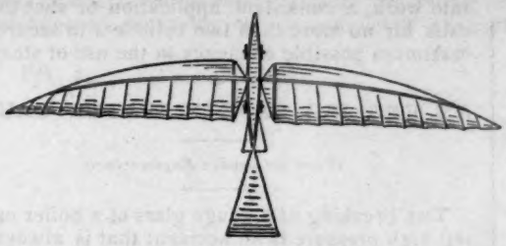


FIG. 21.—DE LOUVRIÉ—1877.

in promoting aviation, and his writings show a better understanding and firmer grasp of the question than most of those which have been published on this intricate subject. He had proposed, in 1863, a sort of kite-like flying machine, which will be noticed under the head of Aeroplanes, and it is said that, in 1888, he presented his latest views before a commission of the French Academy of Sciences, supplementing them with certain experiments, from which he drew the conclusion that an apparatus capable of carrying four passengers needed no more than 3 horse power to drive it at the rate of 67 miles per hour. It may be inferred that the French Commission was not convinced, from the fact that no action has been taken upon the proposal.

(TO BE CONTINUED.)

HOW MANY CYLINDERS WILL IT PAY TO INTRODUCE IN THE MULTI-CYLINDER ENGINE?

BY GEORGE I. ROCKWOOD.

THE records of scientifically conducted tests of double, triple and quadruple compound steam-engines in actual commercial service are rapidly multiplying, and have been given special prominence in the engineering journals of the past three or four years. Out of the wealth of data which they supply, one would think that an unquestionable theory might have been deduced for designers to follow; but the facts supplied stand in such curious and complicated relations to each other, that whatever has been written concerning the theory and design of the compound engine has been generally confused, partial, and fragmentary, and engineers of high degree hold various, and sometimes opposite, opinions as to the causes which conduce to the higher economy of the compound engine over that of the single cylinder engine.

The subject has, however, received one masterly and comprehensive treatment in the paper, entitled "The Philosophy of the Compound Engine," which was read in November, 1889, before the American Society of Mechanical Engineers, by Professor R. H. Thurston, of Cornell University. In this paper the method of inquiry into the causes of wastes of heat in the steam-engine is most searching and scientific, and it must be of the greatest assistance in all attempts at revealing the exact relations of the principles of economy involved. But viewing these relations in the clear light shed upon them by this most valuable paper, it may still be questioned whether some of the conclusions reached are ultimate or even correct. Is it true, for instance, that triple or quadruple-cylinder engines are theoretically necessary to secure the highest degree of economy in the use of steam? May it not rather be true that the use of more than two cylinders in series is positively disadvantageous?

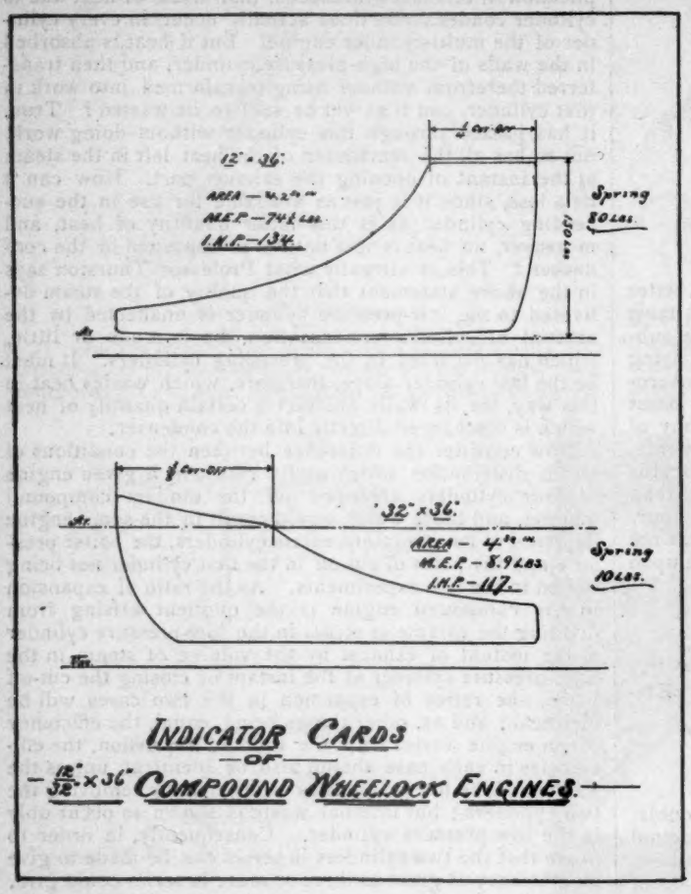
Professor Thurston proved very neatly that the introduction of one or of many cylinders between the low-pressure cylinder and the boiler does not affect the operation of the latter cylinder through cylinder condensation, however great that condensation may be, provided the operation of the added cylinders is effected by raising the steam pressure commensurately, leaving the low-pressure cylinder the same initial pressure as before; and he goes on to say: "The total waste by this form of loss is thus evidently measured in the case of the multi-cylinder engine by the *maximum waste in any one cylinder*." The implication in this last sentence is, that waste of heat due to cylinder condensation does actually occur in every cylinder of the multi-cylinder engine. But if heat is absorbed in the walls of the high-pressure cylinder, and then transferred therefrom without being transformed into work in that cylinder, can it as yet be said to be wasted? True, it has passed through this cylinder without doing work, but so has all the remainder of the heat left in the steam at the instant of opening the exhaust port. How can it be a loss, since it is just as available for use in the succeeding cylinder as is this latter quantity of heat, and moreover, no heat is lost until it is deposited in the condenser? This is virtually what Professor Thurston says in the above statement that the quality of the steam delivered to the low-pressure cylinder is unaffected by the amount of cylinder condensation, be it much or little, which has occurred in the preceding cylinders. It must be the last cylinder alone, therefore, which wastes heat in this way, for its walls abstract a certain quantity of heat which is discharged directly into the condenser.

Now consider the difference between the conditions of steam distribution which would result in a given engine of four cylinders arranged on the tandem compound method, and those which would result in the same engine deprived of its two intermediate cylinders, the boiler pressure and the point of cut-off in the first cylinder not being varied in the two experiments. As the ratio of expansion in the compound engine is the quotient arising from dividing the volume of steam in the low-pressure cylinder at the instant of exhaust by the volume of steam in the high-pressure cylinder at the instant of closing the cut-off valve, the ratios of expansion in the two cases will be identical; and as, other things being equal, the efficiency of an engine varies with the ratio of expansion, the efficiencies in each case should also be identical, unless the amount of the internal wastes is affected by removing the two cylinders; but internal waste is shown to occur only in the low-pressure cylinder. Consequently, in order to prove that the two cylinders in series can be made to give an efficiency as great as three or more in series could give, it is only necessary to show that the same initial and terminal steam pressures and temperatures realized in the low-pressure cylinder of the multi-cylinder engine may be retained, although the two intermediate cylinders be removed from the engine.

It is probably well understood that with a given boiler pressure the average pressure in the receiver, between the high-pressure and low-pressure cylinders of a given double-compound engine, depends solely upon the relation of the volume of steam taken from the boiler by the high-pressure cylinder to the volume of steam taken from the receiver by the low-pressure cylinder, per stroke of the pistons. Should the low-pressure cylinder take a larger volume of steam, before cutting off, than the high-pressure cylinder delivers per stroke to the receiver, the average receiver pressure will be correspondingly lower than the terminal pressure in the high-pressure cylinder. If, therefore, the ratio of cylinder volumes in the double compound engine is the same as the ratio of the volumes of the high-pressure and low-pressure cylinders of a quadruple compound engine, and the points of cut-off in the low-pressure and high-pressure cylinders of each engine are alike, then, with the same boiler pressure in each case, the average pressures of the steam entering each low-pressure cylinder up to cut-off should also be the same, no matter how great the boiler pressure may be. But the extreme variations of the receiver pressure may be reduced as much as desired by increasing the dimensions of the receiver. So, by employing a receiver between the cylinders of the above-described double compound engine, of such proportions that the pressure of the steam delivered to the low-pressure cylinder shall be equal to the

pressure of the steam entering the low-pressure cylinder of the above-described quadruple compound engine, indicator cards taken from each low-pressure cylinder should be identical.

To recapitulate: In the multi-cylinder engine, loss of energy due to cylinder condensation occurs only in the last, or low-pressure cylinder. If the intermediate cylinders be cut out of the circuit, the amount of this loss will not thereby be affected, provided the receiver capacity between the two remaining cylinders is sufficient to keep down the initial steam pressure in the last cylinder to the same intensity naturally occurring when the intermediate cylinders are in use. Therefore, more than two cylinders are theoretically *un*necessary to obtain the maximum possible economy in the use of steam.



INDICATOR CARDS
—OF—
12" & 32" × 36" COMPOUND WHEELOCK ENGINES.

Indicator cards are appended to show the character of the steam distribution in an engine composed simply of the high-pressure and low-pressure cylinders of a triple-expansion engine fitted with the Wheelock valve-gear. Much compression, together with a clean and instantaneous exhaust, is attained. In consequence of the excessively heavy unbalanced pressure in the high-pressure, two-cylinder compound engine, a very pronounced compression is needful to relieve the cut-off valves while opening, and is the only practical difference resulting from doing away with the intermediate cylinders. The Wheelock slide-valve has only $\frac{1}{16}$ in. lap, and it moves across this amount during the dwell of the piston at the end of the stroke.

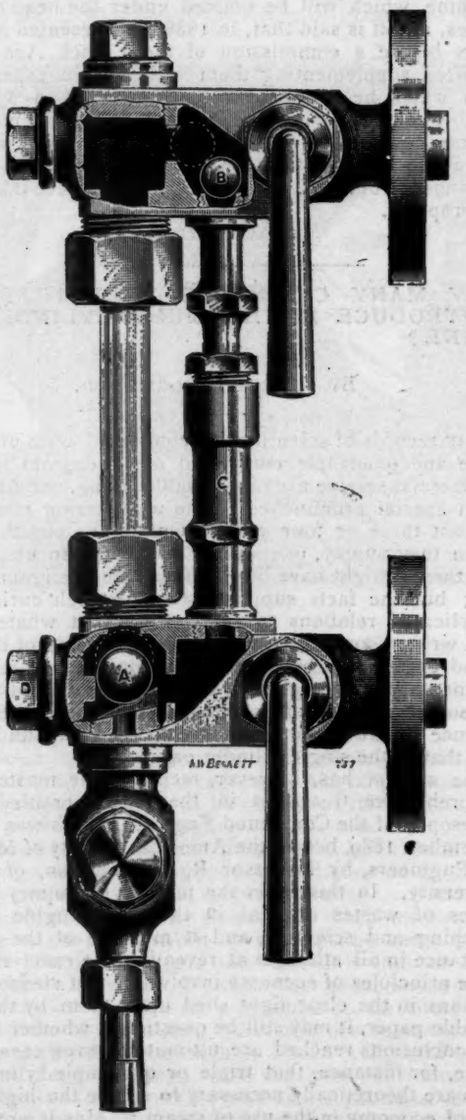
So much for hypothetical argument. But there is a very practical side to all this, for if it is true that more than two cylinders in series are unnecessary to secure to the owner of the engine the very best economy, then there has been a great deal of needless expense in equipping large steam plants of recent construction, as, most notably, in the case of the great plant of the West End Street Railroad, in Boston. The extra expense entailed by the addition of 13 intermediate cylinders, foundations, piping, etc., cannot come much under $60,000 or $70,000, and with the up-keep of all this extra machinery, this sum must bear a goodly percentage of compound interest, all to be added to the before-mentioned sum, and all a needless waste due to a supposed saving in—what? Initial cylinder condensation.

It seems hardly reasonable to doubt that if there be any virtue in the generally held theory, that the waste of the single-cylinder engine is chiefly due to absorption and transference of heat by its walls without transformation into work, a consistent application of that theory calls for no more than two cylinders to secure the maximum possible efficiency in the use of steam.

AN ENGLISH SAFETY WATER GAUGE.

(From the London *Engineering*.)

THE breaking of a gauge glass of a boiler carrying high pressure is an accident that is always inconvenient and generally dangerous. No one would willingly face such an incident, even in a situation where it is possible to get away quickly, for a splash with scalding water is a most fearfully painful experience. But in a confined place, like the foot-plate of a tramway locomotive, or the stoke hold of a torpedo boat, the failure of a glass has several times caused the death of the stoker, not to mention very numer-



A SAFETY WATER GAUGE.

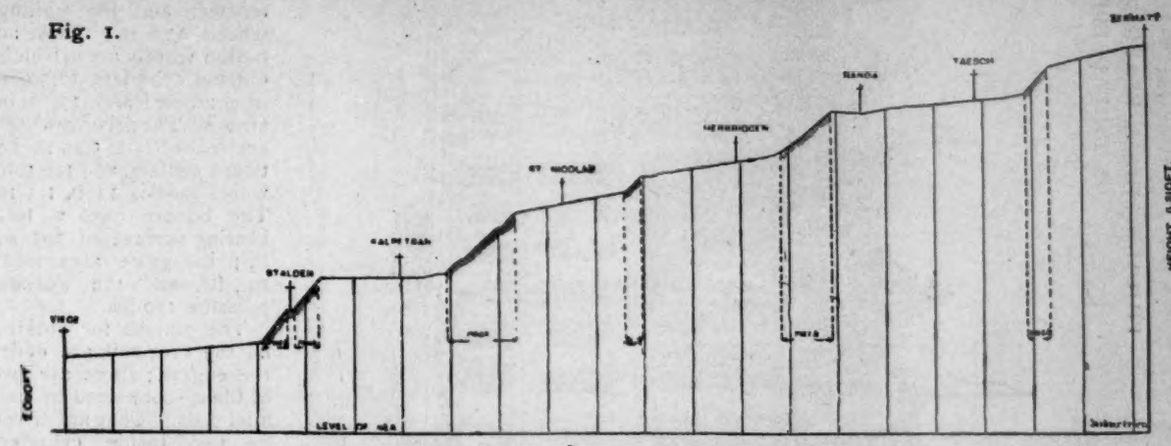
ous injuries. A man need only be caught for a second or two in the rush of boiling water and steam to receive injuries rendering him incapable of flight, and causing him to sink down and be scalded to death.

Several attempts have been made to design gauge fittings that would close automatically upon the breaking of the glass, but without complete success. At length, however, Messrs. J. Hopkinson & Company, of Britannia Works, Huddersfield, have brought out the fitting shown in the annexed engraving, which completely answers all requirements, protecting the stokers perfectly, and being at the same time free from all danger of giving false indications. As will be seen, there is a valve both in the steam and in the water arm, and both these valves come to the seat in case of accident. The lower ball valve *A* is made so heavy that it cannot be held up against its seat by the pressure of the column of water in the boiler, and consequently there is no danger of the water being trapped in the glass and kept there to give a false indication. Further, the ball is of such a weight that it will not be carried up by the rolling of a vessel or the shaking of a locomotive. The ball *B* in the steam arm rests over the upper end of the supplemental tube *C*, as shown, except when it is forced forward against its seat, as shown in dotted lines. It also is safe from dislodgment by shaking.

When a glass breaks the water pressure in the lower arm throws the valve *A* against its seat and stops all escape at the lower end of the glass. At the same time the rush of water up the supplemental tube *C* lifts the valve *B*. This is then forced against its seat by the steam, and thus all escape is cut off instantaneously and certainly. A new glass can then be fitted with safety. Upon closing the cocks and removing the clearing screw *D* in front of the bottom arm, and a similar screw in that of the top arm, the valves will roll out of the gauge.

We are sure that our readers will recognize the merits of this gauge, and that those who are responsible for the safety of stokers will give it further consideration.

Fig. 1.



PROFILE OF THE VIÈGE-ZERMATT RAILROAD.

Fig. 2.

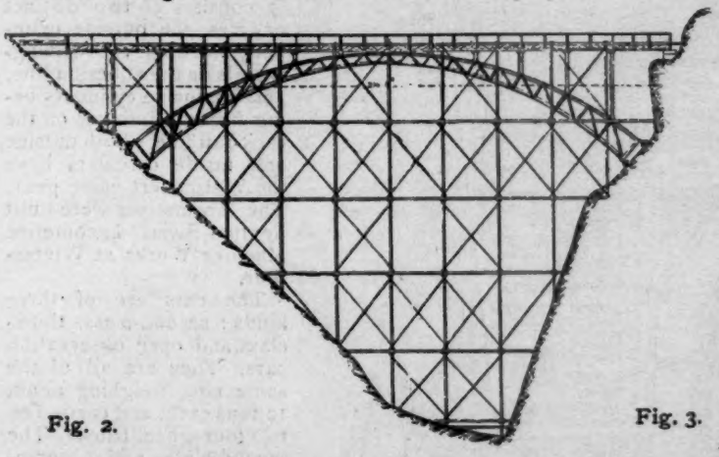
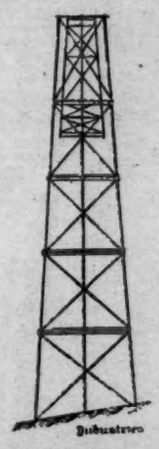


Fig. 3.



THE VIÈGE-ZERMATT RAILROAD.

(Condensed from *Industries*.)

Of the great number of English tourists who every summer visit Switzerland, probably only a comparatively small percentage ever reach Zermatt, and yet the little mountain village, lying high up in the Pennine Alps, is, perhaps, one of the most favored spots in that most favored country. The reason is, however, not far to seek. From Viège, where the Zermatt Valley joins that of the Rhone, some 27 miles of road have to be traversed, for the first 12 of which there only exists a mule path. Travelers leaving the trains of the Jura-Simplon Railroad at Viège had still eight or nine hours' journey before them, for, owing to the mountainous nature of the paths and roads, progress was very slow. Once in Zermatt, however, the discomforts undergone are soon forgotten. For the geologist, the botanist, the mountaineer thirsting for a chance of distinguishing himself, and the invalid—either young or old—there are charms untold. From here the ascents of the Matterhorn, Monte Rosa, and Briethorn are made, and the great glacier panorama of the Gornergrat is only an afternoon's walk distant. It is no wonder, therefore, that in spite of all hindrances more than 12,000 tourists have found their way thither during the last few years, and that Swiss engineering enterprise, stimulated by its previous successes, set itself the task of awakening the echoes of these Alpine solitudes with the shrill whistle of the locomotive.

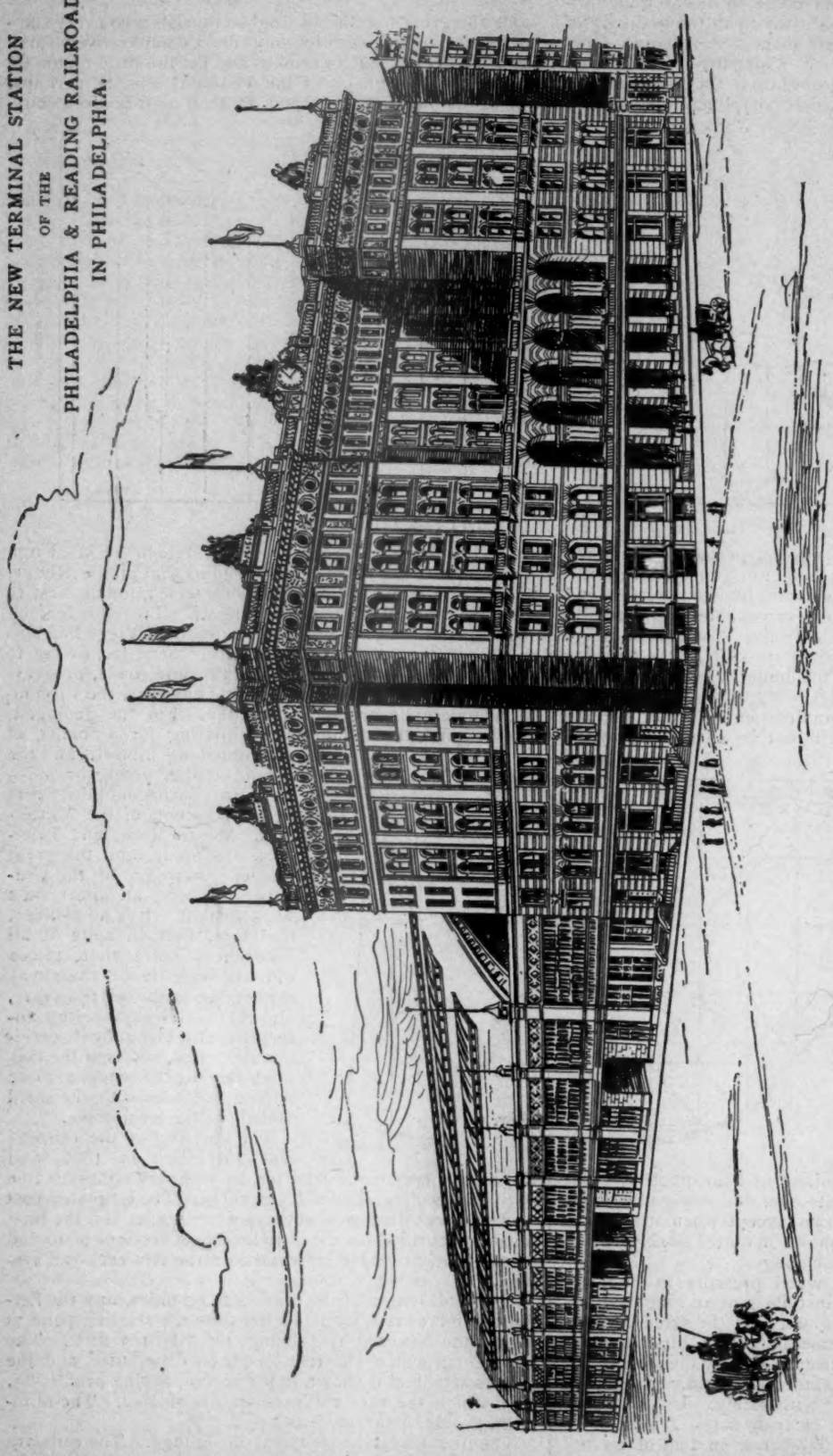
The building of the railroad was authorized in 1886, and the first survey made was for an ordinary adhesion line with maximum grades of 4.5 per cent. The estimated cost was so great that new surveys were made, and the final location provided for the introduction of sections of 10 and 12 per cent. grade, to be worked on the Abt rack-rail system.

The total length of the road is 21.99 miles, and the Zermatt terminus is 3,220 ft. higher than the starting point at Viège, the average rise being 146.5 ft. per mile. The manner in which the rise has been distributed and the grades arranged is shown in the accompanying profile, fig. 1, in which the rack-rail sections are shaded. The minimum radius of curvature is 197 ft.

The line is of 1-meter (39.37 in.) gauge. The rails are 49 lbs. to the yard, of steel, and are laid on steel ties of the Post or box type; these ties are of steel, and weigh 83 lbs. each. The rack-rail on the Abt system consists of two plates, each 1 in. thick for gradients of 10 per cent. and

upward, and ¾ in. thick for gradients between 7 per cent. and 10 per cent. The entrance points of the rack-rail, being carried on springs borne by each sleeper and connected by a link of 1 m. (39.37 in.) in length to the next rail, allow for such slight variations in position as will accommodate the pinions on the axles of the engine. This arrangement permits the engine to enter the rack without slowing down abnormally.

THE NEW TERMINAL STATION OF THE PHILADELPHIA & READING RAILROAD IN PHILADELPHIA.



The locomotives are adapted to both the ordinary and the rack-rail. They have four driving-wheels coupled, a pair of trailing-wheels behind the fire-box, side tanks and a coal-box on the rear end. The driving-wheels are 35.5 in. in diameter, and the trailing-wheels 23.6 in. These adhesion wheels are driven by outside cylinders 12.50 in. in diameter and 17.75 in. stroke. The driving-wheels are spaced 6 ft. 5.25 in. between centers, and the total wheel-base is 14 ft. 1.5 in. The boilers have a total heating surface of 705 sq. ft.; the grate area is 13 sq. ft., and the working pressure 170 lbs.

The pinions for working on the rack-rail are under the engine; there are two of them, connected by parallel rods. They are driven by two inside cylinders placed in the smoke-box, about on a line with the outside cylinders; they are 14.25 in. in diameter and 17.75 in. stroke. The pinions are spaced 36.75 in. between centers; they are 27.25 in. in diameter to the pitch-line, and the teeth are 4.75 in. pitch.

The locomotive thus really consists of two distinct engines, the outside cylinders working the driving-wheels on the adhesion line, and the inside cylinders being brought into use on the rack-rail line. Both outside and inside cylinders have the Walschaert valve gear. The locomotives were built by the Swiss Locomotive Machine Works at Winterthur.

The cars are of three kinds: second-class, third-class and open observation cars. They are all of the same size, weighing about 12 tons each, and carried on two four-wheel trucks. The second-class and observation cars can seat 48 passengers each, and the third-class cars 56. They are fitted with vacuum brakes and with special brakes working on the rack-rail. The locomotives have driver brakes.

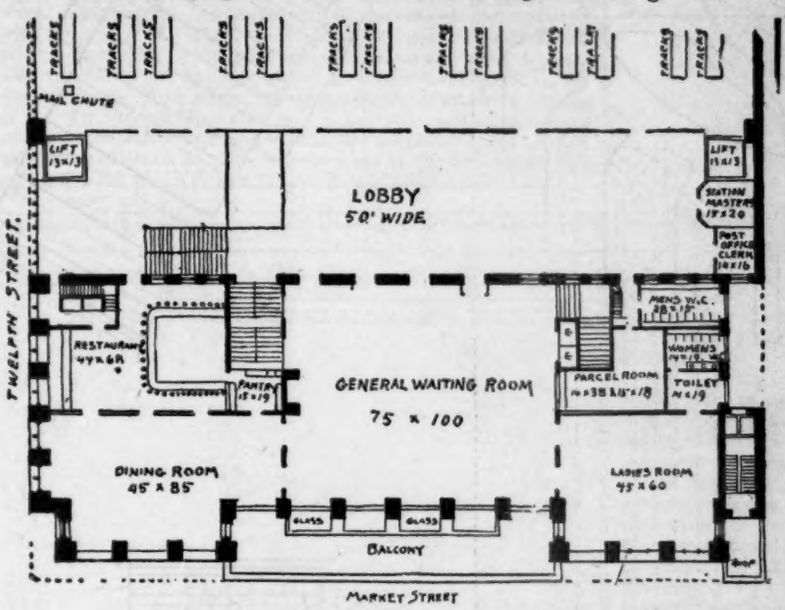
The special works required are not very heavy, as the adoption of the rack-rail and heavy grades permitted the line to follow the natural conformation of the valley. There are five short tunnels, with a total length of 784 ft. There are a number of small bridges, but the only large bridge is the Mühlbach Viaduct, a sketch of which is shown in figs. 2

and 3. This bridge spans a ravine, is 219 ft. long over all, and 148 ft. in height from the bottom of the valley to the rail. The span of the arch is 176 ft. The general construction is shown in the sketch.

This road was partly completed in 1890; it was opened to Zermatt in July last, and carried a large number of passengers this season. It is not operated in the winter. The cost complete, with a single track, was about $50,000 per mile.

THE PHILADELPHIA & READING TERMINAL STATION.

THE new terminal station of the Philadelphia & Reading Railroad Company, in Philadelphia, is probably the most important structure of its kind now in progress in this country. It will replace the old passenger stations, and will, for the first time, give the Reading Company convenient and sufficient accommodations for its business. For the accompanying illustrations, which show a general view of the main building as it will appear when completed, and a plan of the main floor of the station, we are indebted to the Company.



SECOND FLOOR PLAN P&R STATION 12TH & MARKET STS

The main building, which is situated at the corner of Twelfth and Market streets, in Philadelphia, is 266 ft. front on Market Street, 100 ft. deep and 132 ft. high from the pavement to the top of the cornice. It is divided into eight floors, and, as the illustration shows, is of a handsome and rather striking design of the Renaissance order. The material for the lower floors up to the balustrade which surmounts the entrance arches is of a pinkish granite. The upper stories will be of light-colored brick with terra-cotta trimmings.

As will be seen from the illustrations, the lower or ground floor, with the exception of the entrance to the station, which is on a level with the sidewalk, is a few steps below the street; and this long basement is given up to stores, of which there will be six on the Market Street front and one on Twelfth Street. Behind these and under the train-house are the cab-stands and approaches for baggage wagons in the rear of the main building.

On the first floor of the main building are the ticket offices, a large passenger lobby and the baggage rooms. On the corner of Twelfth and Market streets is the treasury department of the Company, and at the other Market Street corner the offices of the Treasurer of the Coal & Iron Company.

The second floor contains the general waiting-room, 100 × 75 ft., with the ladies' room, 44 × 56 ft., to the right, and the dining-room and restaurant to the left. These will be fitted up in the latest and most approved style. In front is a balcony overlooking Market Street, which will be a delightful spot in pleasant weather for persons who have time on their hands waiting for trains.

There is a half story between the second and third floors, which will contain the offices of the operating department of the Reading Terminal Company. The remaining floors will be used for the general offices, now located at No. 227 South Fourth Street. President McLeod's offices will be at the corner of Twelfth and Market streets, on the third floor, adjoining the Board rooms, reception-rooms, etc. The eighth floor will be used for storage and for mechanical apparatus for heating, lighting, etc., all of which will be of the most approved pattern.

The train-shed, which is rear of the main building, has the same width and extends through to Arch Street. The tracks are on a level with the second floor of the main building, and are entered by trains from the elevated structure which the Reading Terminal Company is now building. Filbert Street passes under this shed, and the basement under the train-house from Filbert Street north is occupied by the Market House, which the terminal was required to construct under its contract with the city. The train-house is wide enough to contain 13 tracks with the necessary platforms, and the tracks are of sufficient length to accommodate the longest train usual.

The building has been designed under the direct supervision of President McLeod, who furnished all the main features of the design, and has also paid careful attention to details. His object was to secure a desirable architectural effect with the greatest possible convenience in arrangement, and it is believed that he has succeeded.

Work is now being pushed on the station as fast as possible. The rear end of the train-house and the market-house will be completed during the winter, and it is expected that the building will be so far finished that trains can begin to use it by September next, although the entire structure will not be ready for occupancy before December, 1892.

Philadelphians and other travelers who are obliged to use the present very cramped and inconvenient station of the Company at Ninth and Green streets will appreciate highly the advantages to be gained by the change to the new building.

THE ESSENTIALS OF MECHANICAL DRAWING.

BY M. N. FORNEY.

(Copyright, 1890, by M. N. Forney.)

(*Continued from page 521*)

CHAPTER XIII.—(*Continued.*)

OBLIQUE PROJECTION OF A SPUR WHEEL.*

IN drawing a spur wheel or other object in an oblique position, with respect to the vertical plane of projection, it is necessary, in the first place, to lay down the elevation and plan as if it were parallel to that plane, as represented in figs. 348 and 349. Then transfer the plan to fig. 351, giving it the same inclination to a horizontal line which the wheel in the side view ought to have to a vertical plane. Assuming that the horizontal lines *A G* and *H B* pass through the center and axis of the wheel both in the parallel and oblique projections, figs. 348 and 350, the center of its front face in the latter position will be determined by the intersection of a perpendicular raised from the point *C*, fig. 351, with that axis. Now it is obvious that if we take any point, as *a* in fig. 348, the projection of that point in fig. 350 must be in the line *a' a*, parallel to *A G* and

* The elucidation of the method of drawing an oblique projection of a spur wheel, and the engravings illustrating it, are taken from the "Engineer and Machinists' Drawing-Book."

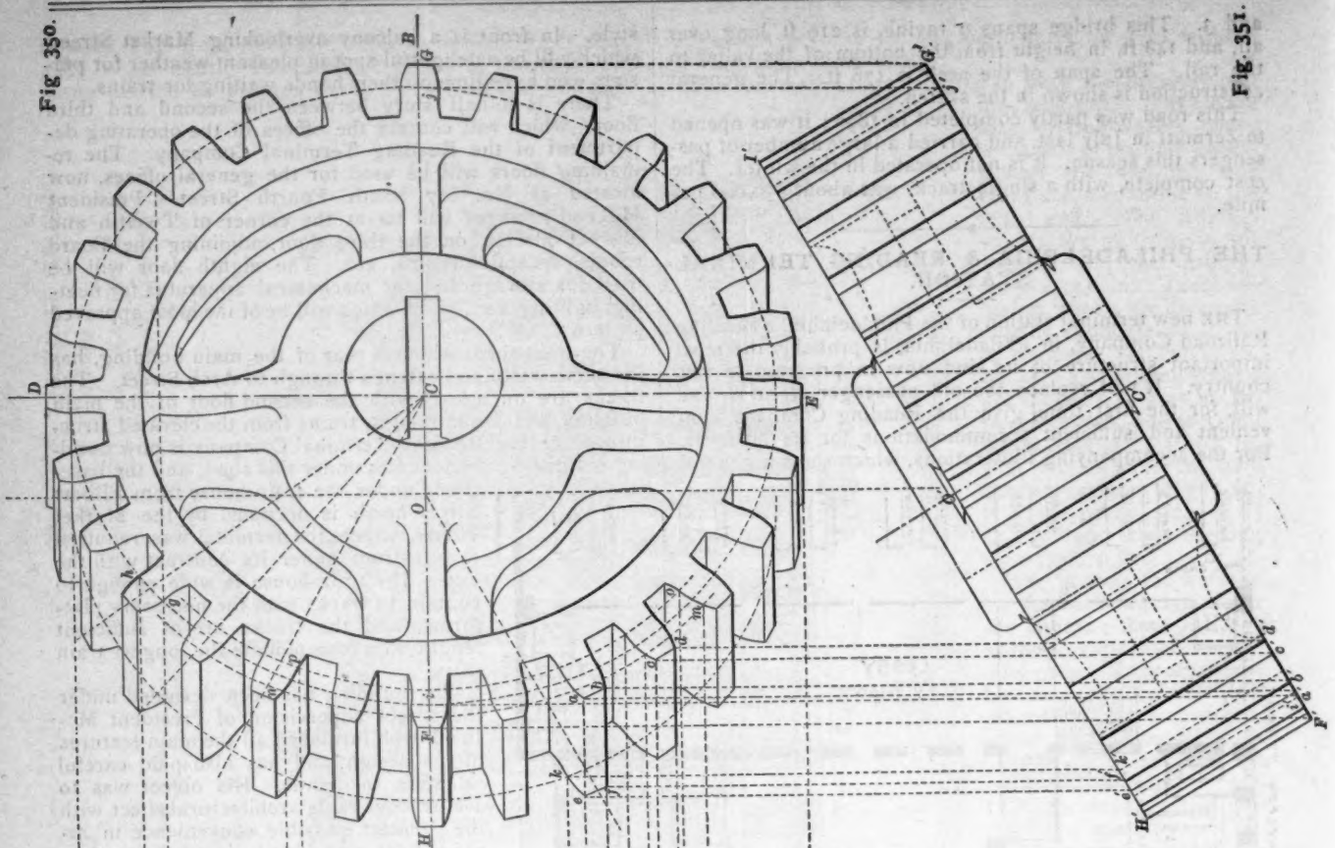


Fig. 350.

Fig. 351.

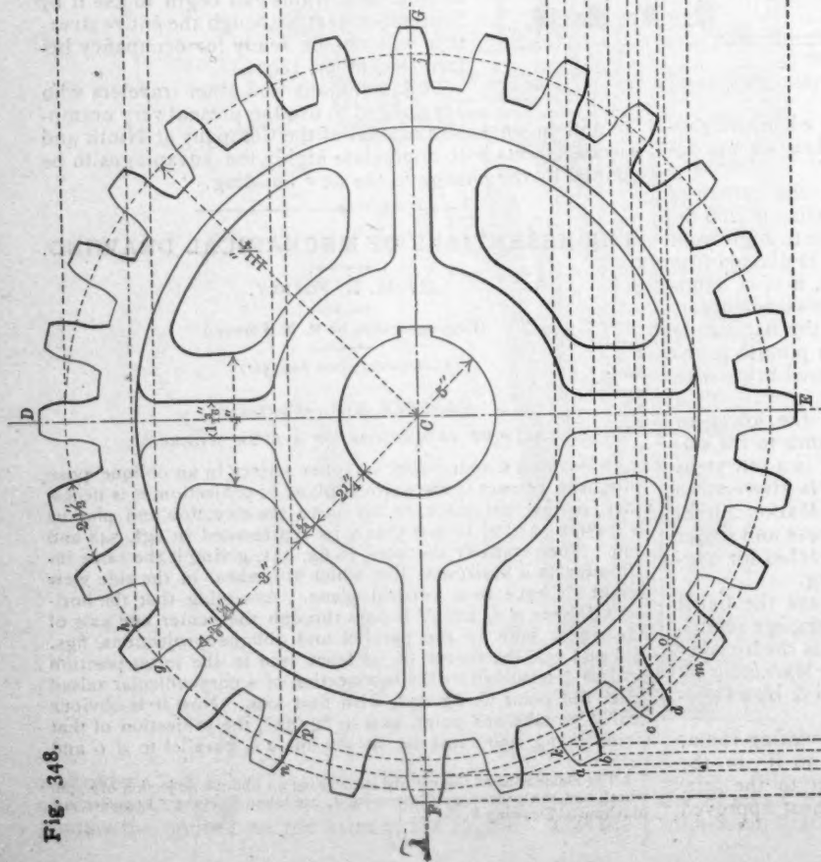


Fig. 348.

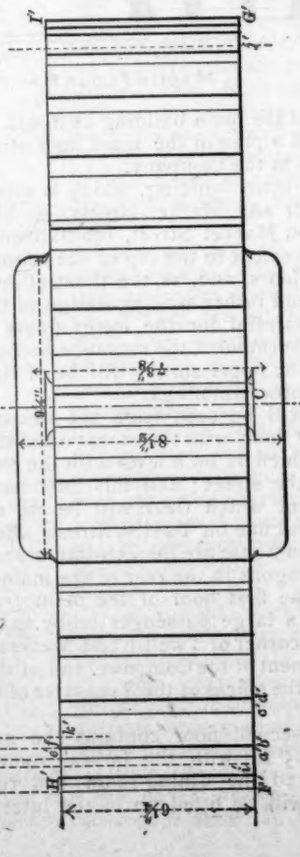


Fig. 349.

H B; and further, this point being projected at *a'* in fig. 349 and transferred to fig. 351, that its projection in fig. 350 must be in the perpendicular *a' a*, figs. 350 and 351. Therefore the intersection of these two lines is the point required. Thus all the remaining points, *b*, *c*, *d*, etc., may be obtained by the intersections of the perpendiculars raised from the points *b'*, *c'*, *d'*, etc., fig. 351, respectively, with the horizontals drawn through the corresponding points in fig. 348. It will also be observed that since the points *e'* and *f'* in the further face of the wheel have their projections in *a* and *b*, fig. 348, their oblique projections will be situated in the lines *a a* and *b b*; but they are also at *e* and *f*; consequently the lines *e a* and *f b*, fig. 350, are the oblique projections of the edges *a' e'* and *b' f'*, fig. 351. We have now to remark that all the circles which, in the rectangular elevation, fig. 348, been employed in the construction of this wheel, are projected in the oblique view into ellipses the length and position of whose axes may be determined without any difficulty; for since the planes *F' G'*, figs. 349 and 351, in which these circles are situated, are vertical, the major axes of all the ellipses in question will obviously be perpendicular to the line *H B* and equal to the diameters of the circles of which they are respectively the projections; and the minor axes, representing the horizontal diameters, will all coincide with the line *H B*. Thus, to obtain the ellipse into which the pitch circle is projected, it is only necessary to set off upon the vertical *D E*, fig. 350, above and below the point *C*, the radius of the pitch circle, whose horizontal diameter *i j* being at *i' j'*, fig. 351, is projected to *i j*, fig. 350; and thus, having obtained the major and minor axes, the ellipse in question may easily be constructed. The intersections of the horizontal lines *g g*, *h h*, etc., figs. 348 and 350, with this circle gives the thickness of the tooth *g h* at the pitch line; and by projecting in the same manner the circles bounding the extremities and roots of the teeth, these points in each individual tooth may be determined by a similar process. But since, in cases where strict accuracy is required, a greater number of points is necessary for the construction of the curvature of the teeth, two additional circles, *n m* and *p o*, may be drawn, fig. 348, and projected to fig. 350, where the corresponding points are indicated by the same letters.

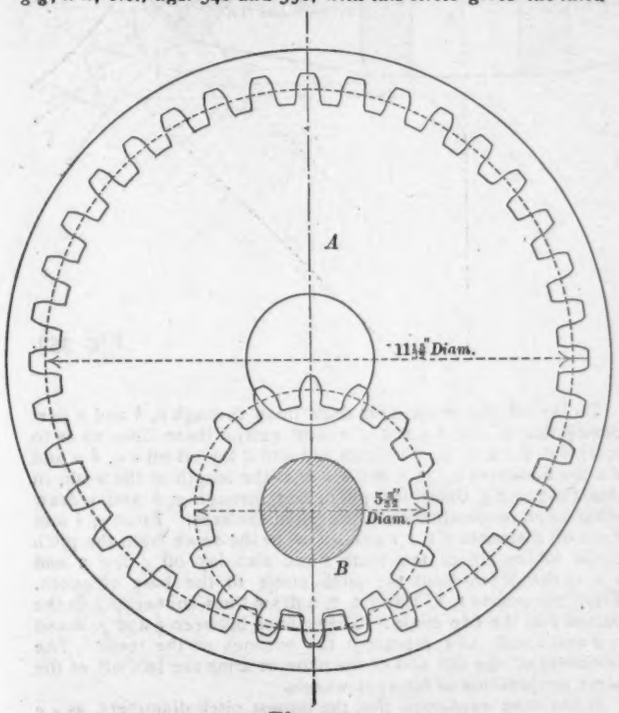


Fig. 352.

It is almost unnecessary to observe that the instructions we have given for the drawing of the anterior or front face *F' G'* of the wheel are equally applicable to the posterior or back face *H' I'*, which is parallel to it, and in all respects the same; the common center of all the circles in it being *O'*, fig. 351, is projected to *O* in fig. 350. Hence it will be easy to construct the ellipses representing these circles in the oblique projection, and consequently to determine the points *e*, *f*, *k*, etc., in the curvature of the teeth; observing that, as their center lines converge to *C* in the front face, they all tend to *O* in the remoter surface, which is, however, for the most part concealed by the former.

It would be superfluous to enter into any details regarding the construction of the oblique view of the rim, hub and arms, which are drawn upon precisely similar principles to those which have already been so fully explained.

INTERNAL GEARS.

Fig. 352 represents a gear wheel, *A*, in which the pinion *B* is within the circumference of the pitch circle. Such gears were formerly quite extensively used, but of late years they have come to be considered as clumsy contrivances, and are rarely used except in special mechanisms.*

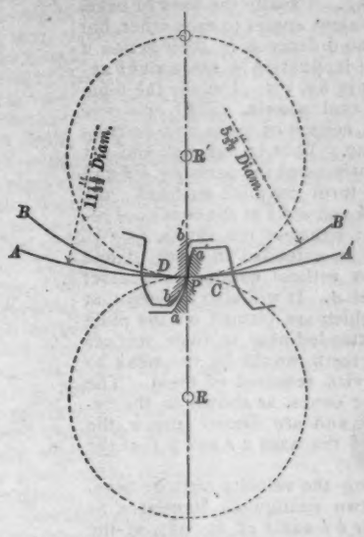


Fig. 353.

The method of laying off cycloid teeth for such gears is as follows:

Let *A A'*, fig. 353, and *B B'* be arcs of the pitch circles of a wheel with 36 teeth of 1 in. pitch, and of an internal geared pinion with 16 teeth, and *P* the pitch-point; *C* a tooth belonging to the wheel, and *D* one on the pinion. The flank *P a* of the tooth *C* works on the face *P b* of the tooth *D*. The outline of the flank *P a* is an epicycloid described by the rolling of a generating circle, *R*, on the pitch circle *A A'* of the wheel; and the outline of the face *P b* of the tooth of the wheel is also an epicycloid, described by the rolling of *R* on the pitch circle *B B'* of the pinion. The face *P a'* of the wheel tooth *C* works with the flank *P b'* of the pinion tooth *D*. The outline of *P a'* is a hypocycloid, described by a generating circle, *R'*, rolling inside of the pitch circle *A A'* of the wheel; and the flank *P b'* is described by the rolling of *R'* inside of the pitch circle *B B'* of the pinion. As the diameter of *R'* is in this case half that of the pitch circle of the pinion, *P b'* is a straight line.†

BEVEL GEARS.

It has been explained that the action of spur wheels in relation to each other is similar to that of two revolving cylinders whose surfaces are in contact and whose axes are parallel. The cylindrical surfaces which are in contact, and whose circular outlines form the pitch circles, may be called the *primitive*

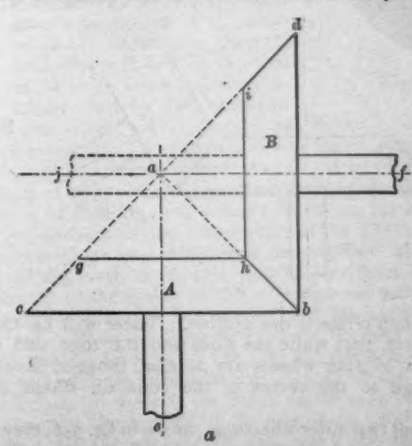


Fig. 354.

* I. Howard Cromwell's "Treatise on Toothed Gearing."
† From Unwin's "Elements of Machine Design."

cylinders or *pitch surfaces*. These can revolve in contact with each other without sliding. If the axes of gear wheels are not parallel and would intersect each other if extended sufficiently, then the pitch surfaces must be cones in order to revolve in contact without sliding. This is shown in fig. 354, in which *a b c* and *a b d* are two cones in contact on the line *a b*; *a e* and *a f* being their axes. It is evident that two such cones can revolve in contact with each other without sliding. Usually the axes of bevel wheels are at right angles to each other, but it will make no difference in their action if their angle of inclination is not a right angle, as shown in fig. 355. Usually the pitch surfaces of bevel wheels, called *primitive* or *pitch cones*, consist of parts only or frustrums of cones. Thus in figs. 354 and 355 the conical surfaces of the parts *c g h b* and *b h i d* would form the pitch surfaces; the portions *a g k* and *a i h* of the cones are removed so that either of the shafts, as *j f*, fig. 355, may be extended in front of one of the wheels without coming in contact with the wheel *A*. It will also be seen that if the teeth which are formed on the pitch cones were extended near to their vertices at *a*, that the teeth would be too weak to stand the service required of them. The vertices of the cones, as shown in the figures, coincide, and are drawn from *a*, the intersection of the axes *a e* and *a f* of the two wheels.

In estimating the velocity ratio of bevel wheels, any two contiguous diameters, as *c b* and *b d* or *k l* and *l m*, fig. 355, of the primitive cones may be taken, but conveniently the largest pitch diameters, as *c b* and *b d*, are usually spoken of as the diameters of the wheel and pinion. Bevel wheels which are of the same diameter are often called *miter wheels*.

The method of laying off a pair of such wheels will first be described. The positions of the axes of the wheels being known—in this case at right angles to each other—their center lines *a f* and *a e*, fig. 356, are drawn. The number of teeth—32—and the pitch—2 in.—being known, a simple calculation gives the diameter of the pitch circles at 20⅜ in. From *a*, the point of intersection of the axes of the two wheels, lay off on *a f* and *a e* distances *a j* and *a k*, each = to 10 3/16 in., or half the pitch diameter. Through the points *j* and *k* thus laid down, draw lines *c b* and *d b* perpendicular to *a f* and *a e*, and from *j* and *k* lay off distances *j d*, *j b*, *k b* and *k c*, each equal to half the diameter of the pitch circle. Then from *c*, *b* and *d* draw lines to *a*; *c a b* and *b a d* will then be the primitive or pitch cones for the two wheels. The teeth must be formed on these cones in somewhat the same way as teeth are constructed for spur wheels on the primitive cylinder of

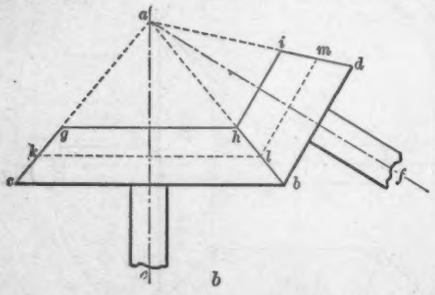


Fig. 355.

which the pitch circle is the outline. There will be the difference, however, that while the sides and the tops and bottoms of the teeth of spur wheels are parallel, those of bevel wheels will converge to the vertex of the cone on which they are formed.

In laying out two miter wheels, as shown in fig. 356, they are represented in section, and are supposed to be cut by a plane passing through their axes. This mode of representation has been adopted for the purpose of enabling us with greater facility to arrive at the true form of the exterior extremities of the teeth, and to show the mode of deriving from them the general form.

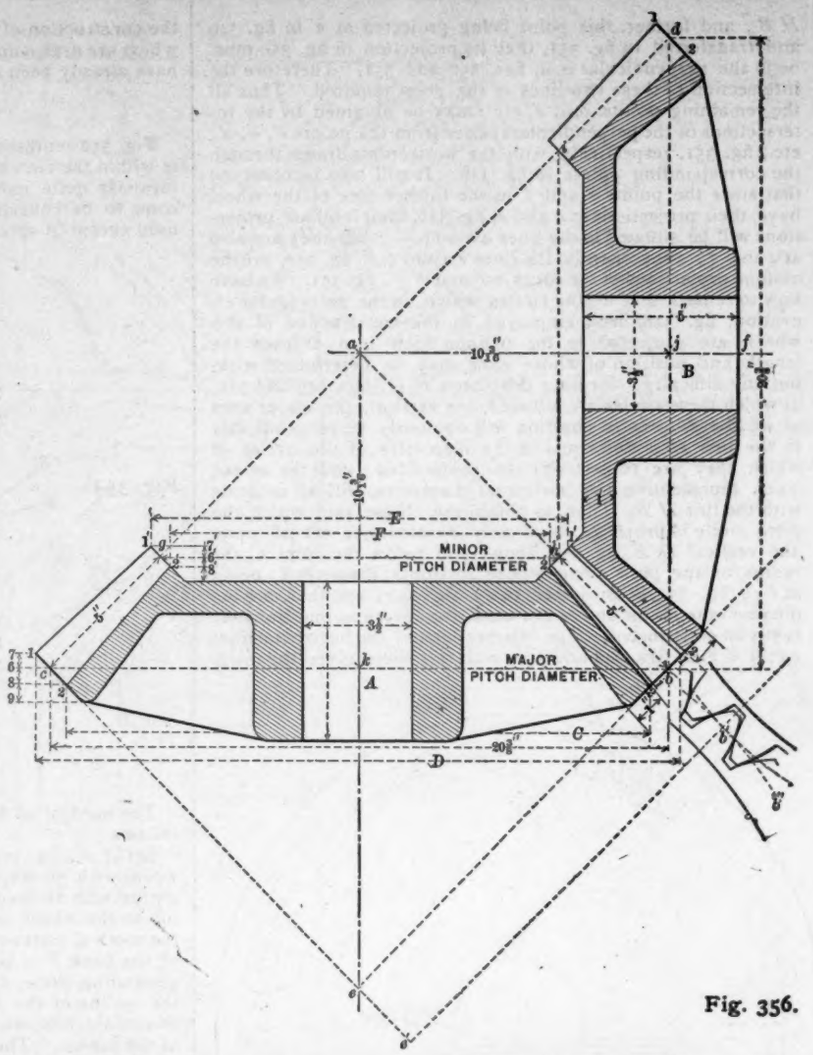


Fig. 356.

To lay off the teeth, first draw lines through *c*, *b* and *d* perpendicular to *c a*, *b a* and *d a*, and extend these lines so as to intersect *a e* and *a f*.* From *c*, *b* and *d* lay off on *c a*, *b a* and *d a* the distances *c g*, *b h* and *d i* = to the length of the teeth, in this case = 2½ times the pitch, and through *g h* and *i* draw other lines perpendicular to the pitch surfaces. From *c*, *b* and *d* set off distances *c* 1, *b* 1 and *d* 1 = to the depth from the pitch circle to the tip of the tooth; and also lay off *c* 2, *b* 2 and *d* 2 = the depth from the pitch circle to the base of tooth. From the points 1, 1, 1 and 2, 2, 2 draw lines converging to the vertex *a* of the two cones. These lines between *c* and *g*, *b* and *c*, *d* and *i* will then represent the outlines of the teeth. The thickness of the rim and of the plate or arms are laid off of the same proportions as for spur wheels.

It has been explained that the largest pitch diameters, as *c b* and *d b*, are usually assumed to be the diameters of the wheels. By connecting the points *g* and *h* or *h* and *i*, fig. 356, we will have another pitch diameter which will be useful in laying out different views of the wheels. The first or larger diameter, *c b*, is called the *major pitch diameter*, and its corresponding circumference the *major pitch circle*; the second or smaller one, *g h*, is called the *minor pitch diameter*, and its circumference the *minor pitch circle*.

In drawing a plan and side view of one of the wheels which is represented in section in fig. 356, first draw a center line, *m o a e*, figs. 357 and 358. Then from *o* as a center and a radius equal to half the major pitch diameter, draw the major pitch circle *p q r s*, fig. 357, and from the same center and a radius equal to half the minor pitch diameter, draw the minor pitch circle *t u v w*. Subdivide the major pitch circle into the required number of equal divisions for the teeth—in this case 32. Take one-half the diameter *D* in fig. 356, measured over the tips 1 1 of the teeth, as a radius, and with it draw a circle from *o*, in fig. 357, outside the major pitch circle; and with another radius = one-half of *C*, fig. 356, the diameter at the roots of the teeth, draw

* To save room in the engraving, the intersection with *a f* is not shown.

another circle from *o* in fig. 357 inside of the major pitch circle. These two circles will define the limits of the outer tips and roots of the teeth in the plan. With one-half the minor diameters *E* and *F* measured over the inner tips and roots of the teeth in fig. 356 draw other circles inside and outside of the minor pitch circle in fig. 357.

In order to lay out the forms of the teeth it will be supposed that the lines drawn through *b* and *c*, fig. 356, perpendicular to

Fig. 357.

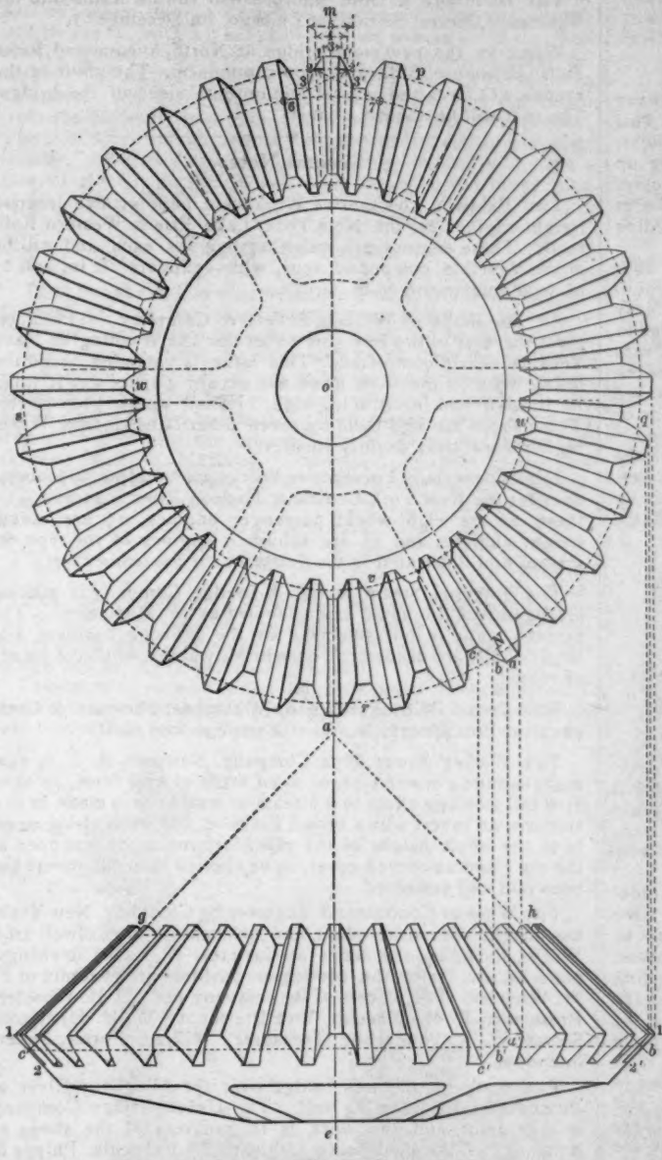


Fig. 358.

the pitch lines *a b* and *a c* are extended to *e*; *c e b* then represents what is called a *tangent cone*, on the surface of which at *c* and *b* the teeth are laid off. As explained in Chapter XIII, if the surface or envelop of a cone is spread out flat it will be a sector of a circle, whose radius is equal to the length *e b* of the side of the cone. In order, therefore, to find the form and dimensions of the teeth, we must conceive a portion of the surface of the cone *b e c* to be developed or spread out upon a plain surface, for which purpose let the line *e b* be supposed to be moved parallel to itself to *e' b'* or to any convenient distance beyond the figure, and with *e' b'* as a radius describe an arc *b b' b''* of a circle, and from a center on *e' b'* extended; and the wheels being each of the same diameter—with the same radius—describe another arc tangent to *b b' b''*. These will be arcs of pitch circles upon which the operation of setting out and drawing the curvature of the teeth is to be performed precisely as in the case of spur gearing.* In the present instance involute teeth have been drawn, but cycloidal teeth may be used.

* "Engineer and Machinists' Drawing-Book."

Then from the points of division for the teeth on the major pitch circle in fig. 357 lay off one-half the thickness of the teeth on each side. Through one of the points of division draw a center line, as *m o*. From fig. 356 take one-half the width of the tip of the tooth, as shown at *b'*, and lay it off each way from the center line *m o*, fig. 357, on the circle outside of the major pitch circle. From fig. 356 take one-half the width of the tooth at its root or base, and in the same way set it off from *m o*, fig. 357, on the circle which has been drawn inside of the major pitch circle. This then gives three points, 1, 2, 3 and 1', 2', 3' in the outline of each side of the tooth, as shown in the plan. From these find centers 6 and 7 of arcs of circles which will each pass through three of the points. Draw a circle of centers 6 7 through the centers of the arcs; then with the radius of the arcs thus found, and from centers located in the circle of centers, similar arcs may be drawn through the points on the pitch circle, which represent the thickness of the teeth, to show the outlines of the outer ends of the teeth in the plan. Having done this, radial lines should be drawn from the corners 1, 1' and 3, 3' of the outer tips and roots of the teeth toward the center *o* and to the circles within and without the minor pitch circle *t u v w*. These lines will represent the corners of the teeth in the plan. From 2 and 2' on the major pitch circle draw radial pencil lines toward *o*, intersecting the minor pitch circle at *t*. The intersections of the radial lines drawn from 1, 1, with the circle outside of the minor pitch circle at *t*, will give the width of the tip of the tooth at its inner end. The intersection of the lines drawn from 2 2' with the minor pitch circle will give the width of the inner end of the tooth on the minor pitch circle, and the intersection of the lines drawn from 3 3' with the circle inside of the minor pitch circle will give the width of the inner end of the tooth at its root. These three intersections will give three points in the outline of the inner end of the tooth through which arcs can be drawn in the same way as already explained for the outer end.

Fig. 359.

For the side view, fig. 358, of the wheel extend the center line *m a* to *e*, and lay down the major pitch diameter *c b* and pitch cone *c a b*, as already explained. Measure off on *c a* and *b a* the length *c g* and *b h* of the teeth, and draw the minor pitch diameter *g h*. Then from fig. 356 take the vertical distance 6 7 of the outside end of the tip of the tooth above the pitch diameter *c b* and lay it off above *c b* in fig. 358, and draw a pencil line, 1 1', parallel to *c b*. Also take the vertical distance 6 8 of the root of the tooth below the pitch diameter from fig. 356, and draw another pencil line, 2 2', in fig. 358, parallel to *c b* at the required distance below it. Proceed in the same way for the smaller ends of the teeth, and draw lines parallel to *g h* to represent the tips and roots at that end. Then from each of the teeth shown in the lower half of fig. 357 project lines, as, for example, *a a'*, from the corners of the outer ends of the tips to the line 1 1'. The intersections at *a'* will define the position of the corner of the tip of the tooth in the side view. Then from *b*, fig. 357, the intersection of the major pitch circle with the side of the tooth, draw another line, *b b'*, intersecting the pitch diameter *c b* at *b'* in fig. 358. Draw a similar line from *c*, the root of the tooth in fig. 357, to the line 2 2' in fig. 358, intersecting it at *c'*. Then *a' b' c'* will be three points in the outline of the tooth through which an arc of a circle or other curve may be drawn which will represent the outline of the end of the tooth. Proceed in the same way for each tooth and mark the points, and then draw curves through these points with a pencil by hand. These may then be inked in most conveniently with the aid of an irregular curved template similar to that shown by fig. 359, which can be adjusted to the curves.

Having laid down the points representing the angles of the

outer ends of the teeth, converging lines should be drawn from them toward the vertex *a*, fig. 358, and intersecting the lines drawn parallel to *g h*, which define the tips and roots of the small ends of the teeth. The curves representing the small ends are laid down in the same way as described for the large ends.

TO BE CONTINUED.

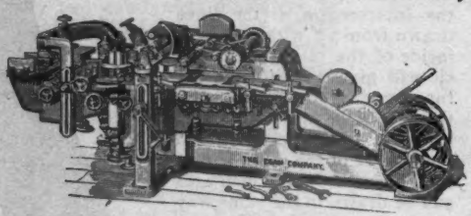
Manufactures.

A Heavy Standard Molder.

THE accompanying illustration represents an extra heavy standard 12-in. molder made by the Egan Company. This machine, it is claimed, is equal in capacity to any inside molder, and has all the advantages of an outside molder in setting up for heavy or light work. It can be used as a timber dresser also, and will dress up 8 × 8-in. timbers on all four sides at one operation. It is especially adapted for heavy building material, car work and the like.

The frame is very heavy, well braced, with ample floor space. It is made extra long, so that the belts have great pulling capacity and every advantage and convenience for easy running. The spindles are made of the best cast steel, large in diameter, and run in extra long self-oiling boxes, lined with genuine Babbitt metal. The patent outside bearing is of the latest improved construction. It goes to the floor and is braced by a solid projection from the base of the frame. No bolts or outside boxes have to be taken off to raise and lower the bed.

The side heads, with their spindles, raise and lower with the table, and both inside and outside spindles are adjustable vertically and horizontally, while in operation, by hand wheels on the front side below the bed. The under head is also adjustable



NEW EXTRA HEAVY 12-IN. STANDARD MOLDER.

laterally. These are great improvements on molders, and will be appreciated by all first-class operators. There are chip breakers to every head, and in this there is a marked advantage, as there can be no tearing on any of the heads, the way these improvements are rigged.

The patent bonnet is adjustable to or from the head, independent of the adjustable shoe, which can be brought clear under the knife. The bonnet swivels on a stud and can be swung clear out of the way, giving free access to the knives. The pressure foot for the lower head is a cored arm, projecting from the back of the frame and supported at the front of the bed, making a very stiff and reliable pressure foot, holding the work down solid to the bed, thereby doing perfect work on the lower cylinder.

The feed is extra powerful, and consists of four rolls, two in the bed and two above, all driven by powerful gearing, and the expansion for driving the lower rolls is very perfect. There are two feeds on the machine. The upper feed spindles are hung on links in such a manner that the feed rolls raise up parallel, giving the feed rolls a full bearing on the board the entire width of the piece. By an improved system of weighting, the feed rolls can be instantly raised up, allowing the operator to slip the board back.

Further information can be obtained from the builders, the Egan Company, Nos. 194–214 Front Street, Cincinnati, Ohio.

Baltimore Notes.

SURVEYS have been made and preparations are being made for the construction of the Washington & Chesapeake Beach Railroad. The road will be 30 miles long, single track, standard gauge, and will run from Washington to a point on Chesapeake Bay near Fair Haven.

WORK on the new electric line to Curtis Bay, to be known as the South Baltimore & Curtis Bay Railroad, will be commenced January 1, 1892, and the road put into operation by March, connecting with the Blue Line horse cars, which will be cabled. The power and car houses will be built by the Ryan & McDonald Company and the South Baltimore Car Works. A 300-H.P. steam plant will be put in the power house, which is to consist of one story about 50 × 90 ft. The building will be constructed of fireproof brick, but the car house will be of iron, 60 × 150 ft. The contract for building the road-bed, etc., has been awarded to Rutherford & Seddon.

THE Mt. Clare Shops, Baltimore & Ohio Railroad, have just received an order for the construction of 31 standard four-wheel caboose cars.

THE Baltimore & Ohio Railroad will run its trains into the Wisconsin Central Station, at Chicago, on December 1.

WORK on the new stone bridge at North Avenue and Jones Falls, Baltimore, Md., will soon commence. The grade of the avenue will be raised several feet on both sides of the bridge. The cost will be about $400,000.

General Notes.

THE Baldwin Locomotive Works are building five decapod freight engines for the New York, Lake Erie & Western Railroad. These engines will weigh 177,000 lbs. each, and will be of the Vauclain compound type, with cylinders 16 in. and 27 in. in diameter and 28 in. stroke.

AT the shops of William Sellers & Company, in Philadelphia, the first of the new gun lathes for the Washington Navy Yard is nearly completed. This lathe is intended to do the fitting work on the 16-in. guns, will occupy a space 133 ft. long, 12 ft. high and 10 ft. 6 in. wide. It will weigh 500,000 lbs. These shops are also building seven other lathes for the Washington Yard, only slightly smaller.

THE Schenectady Locomotive Works are building 50 locomotives for the New York Central & Hudson River Railroad. Of these 20 are eight-wheel passenger engines, 19 are mogul freight engines, and 11 are suburban engines of the type described and illustrated in the JOURNAL for September last.

THE Bucyrus Steam Stovel & Dredge Company is making arrangements to build extensive works in Milwaukee. The present plant is not sufficient for the growing business, and larger shops are needed. Those in Milwaukee will have plenty of room.

THE Cedar Point Furnace of Witherbee, Sherman & Company, at Port Henry, N. Y., will soon go into blast.

THE Waring Sewer Pipe Company, Newport, R. I., is now manufacturing sewer pipe of *beton* made of oval form, so as to give full scouring effect to a stream of water. It is made in two sections, an invert with a broad, flat base, and walls rising nearly to the whole height of the pipe, forming a channel open at the top; and an arched cover, to be applied after the invert has been laid and cemented.

THE Wheeler Condenser & Engineering Company, New York, has bought the entire plant and business of the Colwell Iron Works, including the shops at Carteret, N. J., the drawings, patterns, etc.; also the condenser business and patents of F. M. Wheeler. The officers of the company are: C. H. Wheeler, President; F. M. Wheeler, Vice-President; W. H. Hampton, Secretary; A. Vanderbilt, Treasurer; William Porter, Superintendent.

THE work on the new bridge over the Allegheny River at Pittsburgh is progressing well. The Union Bridge Company is contractor, and the work is in progress at the shops at Athens, Pa., the steel being furnished by Carnegie, Phipps & Company. The bridge will have two spans, each 445 ft. long, of the bowstring girder type, and a deck plate girder span of 41½ ft. over the Pittsburgh & Western Railroad on the Allegheny side. The height of the large truss at the center is 79½ ft. clear, and the width of the roadway will be 40 ft., accommodating four lines of track, two to be used for street-car traffic and two for wagon traffic; the two sidewalks will be 9 ft. each in the clear, protected by hand railings.

THE Continental Iron Works, Brooklyn, N. Y., report an increasing demand for corrugated flues for boiler furnaces, and the works are very busy. In this connection it may be noted that at a recent meeting the Board of Supervising Inspectors of Steam Vessels raised the constant for corrugated furnaces from 12,500 to 14,000, allowing an increase of about 12 per cent. over the old formula in steam pressure on boilers with corrugated furnaces.

IN the United States Circuit Court, in Chicago, recently, in the case of Pettibone & Mulliken against Arthur L. Stanford, Judge Gresham decided in favor of the defendant, holding that his track-jack as made and sold was not an infringement of plaintiff's patents.

THE Ranken & Fritsch Foundry & Machine Company has recently made extensive improvements in its works in St. Louis, and has added a number of tools to its plant. Mr. Joseph H. Springer, late of the Niles Tool Works, is now General Manager of this company, succeeding the late Mr. Bruno Fritsch.

THE iron roof for the store house which the United States Government is building at Willett's Point, L. I., will be furnished by the Berlin Iron Bridge Co., of East Berlin, Conn.

A NEW suspension bridge is to be built in Golden Gate Park, San Francisco, over a depressed roadway. The total length will be 140 ft., with a clear span between towers of 60 ft. The towers will be of steel, each consisting of a group of eight columns. The cables will be of steel wire, and will be 2¼ in. in diameter. The floor will rest on 12-in. steel beams suspended from the cables by iron rods, and braced together transversely. The iron side-railings are so designed as to act as stiffening trusses. The roadway will be 23 feet. wide, and will have a camber of 3 ft.; the height will be 17 ft. above the lower road at the center.

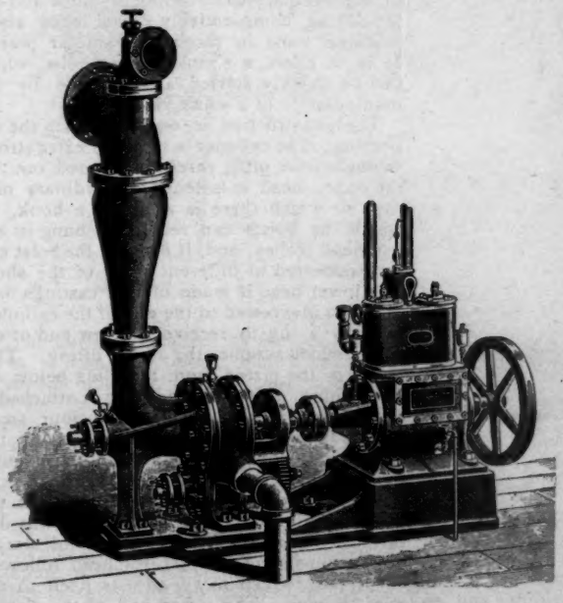
Car Heater Patents.

THE Board of Examiners of the Patent Office decided, on October 28, four important interferences, covering practically the basic principles of car heating by disk, coil or other drums. The result of these decisions will be to limit the use of the steam drum or jacket of any form in connection with a hot-water circulating system in a car, to the Consolidated, the Safety and the Gold companies. The patents which will issue under the decisions are granted, one to Henry R. Towne and three to James F. McElroy. This does not affect in any way the commingler, in which steam is noiselessly injected into the water of circulation in a car.

Condensers.

THE use of condensing engines in ordinary work in this country is not very common, the great majority of stationary engines being non-condensing. There are many reasons for this which can hardly be given here in full.

In general it may be stated that only under the exceptionally favorable conditions of a properly proportioned condenser of an economical type, an engine not too large for the work, and



AN IMPROVED CONDENSER.

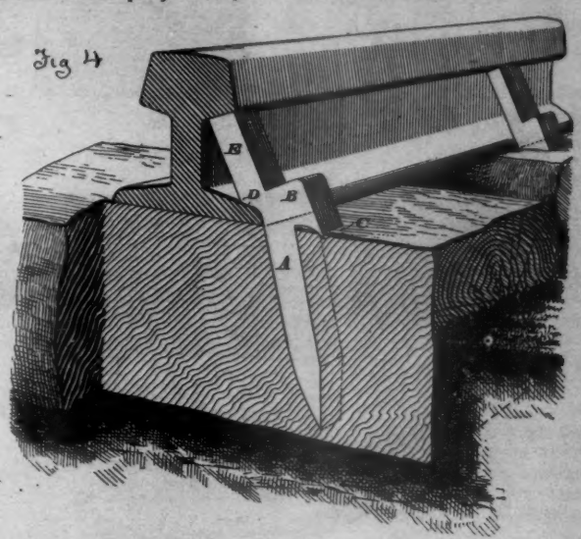
a load variable to but a slight degree, is a condenser at all advisable. So seldom are these conditions realized in practice that probably not one plant in five could be run with this extra mechanism at a profit over and above what could be obtained without it and with a good form of feed-water heater. Repeated expert tests have shown this to be true; and a better proof is the general acceptance of the fact by those most interested—the manufacturers.

In the few cases where it is undoubtedly commercially valuable, the structural disadvantages of the independent condenser has been against it as much as the inefficiency of the independent system.

Recently a combination which incorporates the advantages of both has been designed. It consists of a Dow positive rotary pump, coupled direct to a small Westinghouse engine, as illustrated in the annexed cut, and is briefly a *high-speed independent condenser*, with all the economy of operation found in the *belted* form. With the results indicated by a practical test of this form of condenser in the New England States during the past year, many of the objections to such a plant are removed, and the possibility of economy extended over a greater range of unfavorable conditions.

A Novel Railroad Spike.

FIG. 4 shows a spike of a new design for which patent No. 462,045 was recently issued to Mr. Daniel Hegarty, of Philadelphia. This invention consists of a spike provided with means for supporting the head of a rail, making the rail solid, and preventing shifting thereof, as will be hereinafter set forth and definitely claimed. In the drawing, which is a perspective view, partly in section, *A* is a spike, on one side of the head *B* of which is a depending pointed or sharpened tooth *C*, and on the opposite side thereof is a shoulder *D*. Rising from the shoulder *D* is an arm *E*, which extends from the head in a direction obliquely toward the rail.



HEGARTY'S RAILROAD SPIKE.

The spike is driven obliquely into the tie, the blows being struck upon the head *B*, and when it is home the shoulder engages with the base of the rail, the tooth enters the tie, and the arm *E* is beneath the head of the rail and in contact with the under side thereof, thus forming a support and brace for said head. As the tooth enters the tie, lateral shifting of the head of the spike is prevented, and as the shoulder interlocks with the base of the rail and the head of the latter is sustained by the arm, as has been stated, the rail is held solidly and well adapted to sustain the strain to which it is subjected by car-wheels on the gauge side.

The spike and its connected parts are made in one piece, thus possessing strength and durability, and constructed of iron, steel or other suitable metal.

A Large Dry-Dock.

THE largest dry-dock on the Lakes has just been completed by the Detroit Dry-Dock Company at its Orleans Street Yard, in Detroit. It was built by A. J. Dupins as contractor, under the supervision of J. C. Parker, Superintendent of the yard, and cost in all over $200,000. It will take in a loaded ship carrying a cargo of 3,000 tons. In the foundation of the dock over 2,000 piles were driven.

The inside dimensions are: 378 ft. long; 91 ft. wide on top; 78 ft. opening at entrance; 54 ft. opening on miter-sill; 55 ft. wide on floor; 16 ft. 6 in. of water over keel-blocks; 16 ft. 6 in. of water over sill; 4 ft. 6 in. from top of keel-blocks to floor of dock; 20 ft. 6 in. from water-line to floor of dock.

The Sewall Coupler for Steam Heating.

THE Sewall, which is the original straight-port and insulated steam coupler, is now used by 88 railroads, having a mileage of 43,931 miles in the United States and Canada, and having 8,922 passenger cars. The long and wide use of this coupler is the best demonstration of its merits in actual service. The cuts herewith published show its construction.

The passage for steam is practically straight, and thoroughly unobstructed by strainers, springs, diaphragms, gasket retainers or acute angles. All metallic parts of the coupler are made of malleable or wrought iron or steel.

On the coupler-head are placed a tooth and space, in proper position (shown at *H* and *I* in fig. 1), to serve the double purpose of a guide for the interlocking devices when being coupled, and also to retain the coupler-heads in proper relation while uncoupling. The locking features are constructed upon carefully calculated epicycloidal curves, thereby drawing the gaskets together in a direct line through the locking devices, and hence gravity tightens the faces. That the coupler is automatic in uncoupling is due to the curvature of the hose nipple (shown in fig. 4), the center line of draft being brought above the center line of pressure as soon as hose begins to approach a horizontal position. The gaskets are composed of peculiarly treated rubber, and have sufficient elasticity, as well as strength, to form a perfect and durable steam joint. The gasket is tightly pressed upon the inner face of the coupler-head by the hose nipple being forced against it, and is held rigidly in place by studs and nuts shown in fig. 4. A new gasket is readily put in place when occasion requires.

Fig. 1.

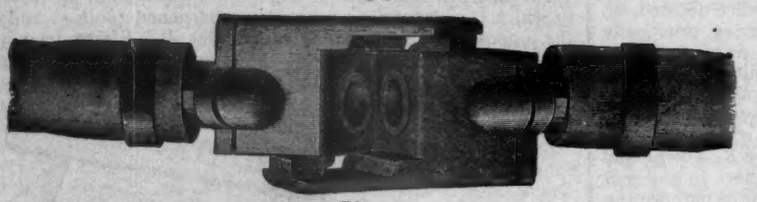


Fig. 2.

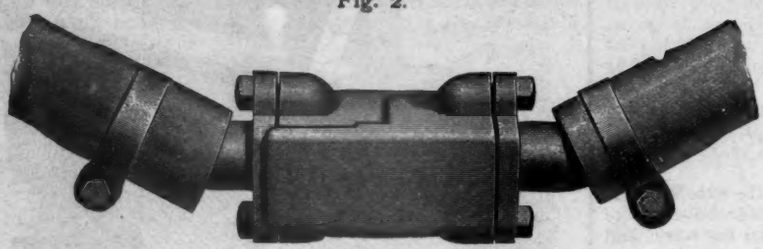


Fig. 3.

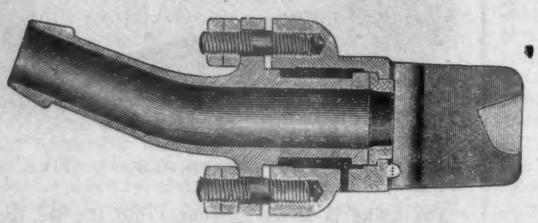


Fig. 4.

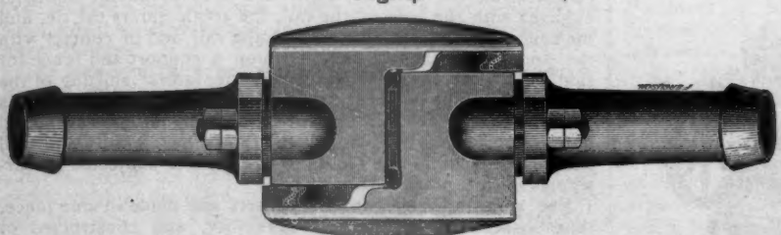


Fig. 5.

THE SEWALL COUPLER FOR STEAM HEATING.

Condensation is provided against by insulating the hose-nipple or steam tube by a dead air space completely surrounding the steam tube within the coupler-head. This is the only steam coupler now in use which makes any endeavor to insulate the metallic parts exposed to the atmosphere, and so to prevent unnecessary condensation.

The parts of the Sewall coupler are but five—the coupler-head, the nipple, the gasket, the studs, the nuts. It has no need of springs, traps, diaphragms or movable steam faces to make it sufficient. The Sewall has no movable parts, and hence should be durable.

Other advantages claimed are that it is steam tight; it hangs below the air coupling; it uncouples automatically; it couples easily; it is most widely used; it is not a cheap coupling, but is the most economical.

The standard measurements adopted for the application of the Sewall coupler throughout the United States and Canada are as follows: Train-pipe to terminate on right-hand side as one looks out of the car and at a distance of 13 in. from the buffer face; termination of train-pipe to be also 12 in. to the right of the center line of the car, and 32 in. from the top of rail; hose to be 23 in. long; support chains from center of eye plate to center of hook on standard passenger cars to be 34 in. long; train-pipe to be of 1½-in. pipe, terminating with 1½-in. standard thread 45° ell; offset in train-pipe to be as shown in blue prints; 45° ell to be screwed on train-pipe so as to point slightly toward center line of car.

The careful observance of these standards has made possible the present wide interchange of several thousand cars already equipped with the Sewall coupler.

A Pneumatic Hoist.

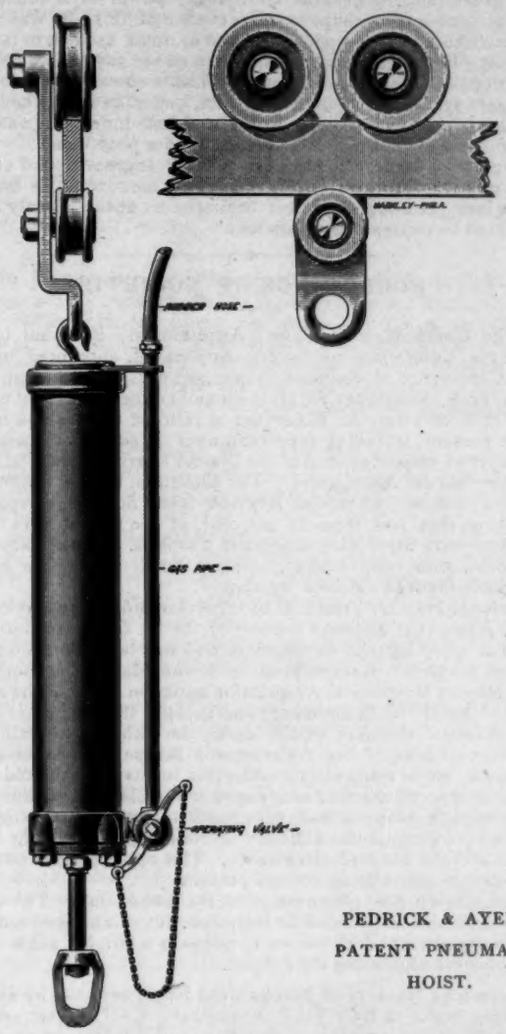
THE accompanying engraving shows a pneumatic hoist intended to take the place of the ordinary chain hoist or block-and-fall for lifting comparatively light loads about machine tools, in shops and similar places. It is, in effect, a simple power hoist, which can be quickly started and stopped by the manipulation of a small valve.

The construction is well shown in the engraving. The cylinder is small, of extra strong wrought-iron pipe, carefully reamed out; to the upper head is fastened an ordinary pipe cap, to which there is attached a hook, by which the hoists can readily be hung to the overhead trolley, and, if desired, the hoist can be transferred to different parts of the shop. The lower head is made of two castings, one of which is screwed to the end of the cylinder, and has a lug to receive a screw end of the valve, which supplies the air for lifting. This prevents the piston from traveling below the air opening. To this lower ring is attached a head which is held in place by four small studs and nuts; this head also contains the stuffing-box for packing around the piston-rod; by this construction the lower head can be readily removed for an examination of the piston and its packing without in any way disturbing the hoist. The piston is of simple design, consisting of a cast-iron head, follower-plate and a leather cup-ring, which nicely adjusts itself to the cylinder and prevents leakage. The lower end of the piston-rod has a swivel which allows the ring to be turned to any desired position in the rod. The piston acts but one way, as it has been found that the weight of the load, or even of the piston-rod and head, is sufficient to allow it to drop when the pressure from the lower end is relieved.

The valve consists of but four parts—a body, valve-stem, cap and small spring to keep the valve-stem in place, which, with the air pressure, keeps the stem in constant pressure against the body. One side of the valve is provided with a lug, by which it is attached to the lower ring of the hoist; the valve requires no packing, and is of such a construction as to be readily

and cheaply repaired, although, after a constant service of over a year, no appreciable wear has been noticed. The parts of the hoist are all strong and substantial; all the parts submitted to strain are steel or wrought iron; the upper and lower heads are of cast iron, as is also the valve, the stem of which is carefully ground to a seat in the valve body.

The lifting capacities of these hoists, when 80 lbs. air pressure is used, are: 3 in. diameter, 450 lbs.; 4 in., 800 lbs.; 6 in., 1,800 lbs.; 8 in., 3,200 lbs.



PEDRICK & AYER'S PATENT PNEUMATIC HOIST.

The power is supplied by an air compressor, one of which is 6 in. to 8 in. in diameter, with a storage tank of about 3 ft. in diameter and 5 ft. long, and will supply sufficient compressed air for 12 to 18 hoists having average use. For special purposes, such as where the hoist is used constantly, a less number can be supplied by a compressor of the above size. Hose is attached to the upper end of the wrought-iron pipe, the length of the hose depending upon the floor area which it is desired the hoist should cover.

The advantages claimed for these hoists are the saving in time and labor over the ordinary block hoist, and the additional amount of work which their use will enable a tool to get through. They are made by the well-known firm of Pedrick & Ayer, of Philadelphia.

PERSONALS.

JOHN B. LINN, recently City Engineer of Springfield, O., is now connected with the Pittsburgh Bridge Company.

GEORGE T. JARVIS is now General Superintendent of the Lake Erie & Western Railroad, succeeding D. S. HILL, resigned.

CLEM HACKNEY, formerly Superintendent of Motive Power of the Union Pacific, is now General Manager of the Fox Solid Pressed Steel Company, of Chicago.

WILLIAM HASSMAN has been appointed Superintendent of Motive Power of the Western Division of the Newport News & Mississippi Valley Company's lines.

CHARLES H. WIGGIN has been appointed Master Mechanic of the Concord Division of the Boston & Maine Railroad. He was recently Foreman of the Boston shops.

J. F. HOLLOWAY, of New York, was recently elected an Honorary Member of the Civil Engineers' Club of Cleveland, O. Mr. Holloway was one of the founders of the Club, and for three years was its President.

COLONEL PETER C. HAINS, U. S. Engineers, has been relieved from duty at Washington, and ordered to the headquarters of the Department of Dakota, at St. Paul. Colonel Hains has had charge of the reclamation of the Potomac Flats.

HENRY M. SPERRY has been appointed General Agent of the Johnson Railroad Signal Company, with office in Chicago. He is an expert signal engineer, and has been for 10 years past with the Pennsylvania Railroad; since 1887 he has been Supervisor of Signals of the New York Division.

J. MADISON PORTER has been chosen Professor of Civil Engineering in Lafayette College at Easton, Pa. He has been assisting as instructor in that department since the death of Professor Fox. Professor Porter has been for some time connected with the firm of Tippett & Wood at Phillipsburg, N. J.

OBITUARY.

JOHN GREGORY SMITH, who died in St. Albans, Vt., November 6, aged 73 years, was Trustee and Receiver of the Vermont Central and afterward President of the Central Vermont Company. He was also for several years President of the Northern Pacific Company. He served two years as Governor of Vermont.

COLONEL SAMUEL S. F. CHALFIN, who died in Savannah, Ga., November 1, was a graduate of West Point, and served during the Mexican War. After that he settled in Brooklyn, and was employed for a number of years as a civil engineer. For some 10 years past he has been connected with the City Department of Public Works.

LEWIS LYON, who died in New York, October 29, aged 61 years, had been President of the Third Avenue Railroad Company for 13 years. He first introduced the cable system in New York—the building of the Amsterdam Avenue & 125th Street line being chiefly due to him—and he had only recently secured the adoption of the same system for the main line.

WILLIAM M. PARKER, who died in Manchester, N. H., October 29, aged 70 years, was the first Assistant Superintendent of the Hudson River Railroad. He afterward had charge at different times of the Northern New Hampshire, the Boston, Hartford & Erie, the Connecticut & Passumsic Rivers, and of the Boston & Lowell Railroads, but for some time past has retired from business.

ALFRED C. HOBBS, the inventor of the celebrated Hobbs lock, died in Bridgeport, Conn., November 6, aged 79 years. He established a firm in London, while on a visit there in 1851, but afterward returned to this country and was Superintendent of the Howe Sewing Machine Works and later of the Union Metallic Cartridge Works in Bridgeport. He retired from business three years ago.

COLONEL JOHN A. WRIGHT, who died in Philadelphia, November 1, was one of the incorporators of the Pennsylvania Railroad Company, and assisted in securing the charter of that company in 1845. He was an officer of the company for a number of years, and was appointed its first Chief Engineer.

He retired from active work a number of years ago, his last active service being as a member of the Board of Abritration chosen by the trunk lines in 1879, the other members being David A. Wells and Charles Francis Adams. Colonel Wright was 71 years old at the time of his death.

COLONEL SAMUEL H. LOCKETT died in Bogota, Colombia, October 12. He went there last year as Chief Engineer for the new water works of the city. He graduated from West Point, and served in the Engineer Corps a few years. During the war he served in the Confederate Army, and was later in the Egyptian service for a time. Returning to the United States, he assisted General Stone in putting up the statue of Liberty in New York Harbor, and afterward built up a considerable practice as consulting engineer for water works. For several years past he had spent much time in South America.

DR. JOHN FRANCIS WILLIAMS, who died in Ithaca, N. Y., November 9, aged 29 years, graduated from the Rensselaer Polytechnic Institute at Troy, and subsequently studied at Göttingen, in Germany. He was for a short time engaged in teaching at Clark University, in Worcester, Mass., and was then appointed Assistant Geologist on the Arkansas State Survey, where he did some excellent work. Last summer he was appointed Assistant Professor of Geology in Cornell University, and had just begun his work there, with excellent prospects of success. Dr. Williams wrote several excellent short articles on geological topics, some of which appeared in the JOURNAL, and his early death has closed a very promising career.

MONCURE ROBINSON, who died in Philadelphia, November 10, aged 89 years, was born in Richmond, Va., and graduated from William and Mary College when only 16 years old. He began work as an assistant on the first topographic survey made of a line from Richmond to the Ohio River, and was afterward employed on the James River Kanawha Canal. In 1825 he went to Europe and spent three years in study, and in 1828 he was employed by Stephen Girard in surveying some lines in the anthracite coal fields. In 1830 he built the old Clover Hill coal road near Richmond, and afterward made the surveys for the Richmond & Petersburg, the Petersburg and the Richmond, Fredericksburg & Potomac roads.

In 1835 Mr. Robinson removed to Philadelphia, and there he made the surveys for and located the Philadelphia & Reading Railroad from Pottsville to Philadelphia. He was engaged also in the construction of the Chesapeake & Delaware Canal and in some surveys in Georgia. His reputation was such that he was invited to take charge of the building of the first railroads in Russia, but declined. In 1842 he took charge of the building of the dry-dock at the Brooklyn Navy Yard. A few years later he practically retired from the practice of his profession, though he was often called on to act as consulting engineer. He took an active part in the building of the Seaboard & Roanoke and the Raleigh & Gaston roads and their extensions, in which he held a large interest.

Mr. Robinson was an honorary member of the American Society of Engineers and the Engineers' Club of Philadelphia. He leaves five sons and three daughters, the oldest son, John M. Robinson, having been for a number of years President of the Seaboard & Roanoke and its controlled companies.

JOHN MARSTON GOODWIN, who died in Sharpsville, Pa., October 27, aged 57 years, was born in Boston, where his father was for a number of years Superintendent of the Massachusetts General Hospital. When only 15 years old he entered upon work as Assistant in the engineer corps of the Vermont & Canada Railroad, and he was later employed on the Vermont Central and some lines in Eastern Canada. In 1856 he was employed on the La Crosse & Milwaukee, and later was on the Michigan Southern & Northern Indiana. During the war he was engaged with Colonel Thomas A. Scott and Peter C. Watson in some mining enterprises in Kentucky. When Mr. Watson was made President of the Erie, Mr. Goodwin was for a time his Assistant, and did excellent service. Later he was Chief Engineer of the Sharpsville Railroad, which was located and built under his charge. He was employed as consulting engineer on several enterprises, and was recently made a member of the Pennsylvania Ship Canal Commission. He made the surveys for the line which the Commission proposed to the Pennsylvania Legislature, and was actively engaged in that work at the time of his death. He died of brain fever after a short illness. He leaves a wife and several children.

John M. Goodwin was a man of extraordinary attainments, and very few men possessed such an extensive range of knowledge. Unlike most men of whom this can be said, however, his knowledge was exact and particular in almost every case. He would have succeeded excellently as a Mechanical Engineer, but preferred civil engineering, although his talent led him to invent several devices, including a dump car which has come into extensive use, and a rotary engine, upon which he was engaged recently in the intervals of his canal work; he also devised a system of cable towing for canals. He was a frequent contributor to technical journals and society proceedings, but although always willing to impart knowledge to others, he was very reluctant to engage in any extensive literary work. With his great fund of general knowledge, power of acquiring information—and perhaps in consequence of this—he was somewhat discursive in temperament, and at times seemed to lack the faculty of concentration. Many men of his powers would have acquired a large fortune; but what has been called the instinct for gain seemed to be lacking in him, and although he had been engaged in many important works, and had done a large amount of work in the course of his life, he died a poor man.

He had a large acquaintance among engineers and others, and was almost universally liked. Few men could be his enemies long, although he never hesitated to speak plainly or attempted to conceal his opinions.

PROCEEDINGS OF SOCIETIES.

The Committee on Safety Appliances.—Pursuant to notice, the Committee on Safety Appliances, appointed by the last Conference of Railroad Commissioners, held a meeting in New York, November 10, all the members being present except Mr. Hill, of Virginia. A number of railroad officers and others were present, including representatives of several associations of railroad employés, and of the Master Car-Builders' and Master Mechanics' Association. The Chairman of the Committee read a number of replies received from railroad companies, showing that less than 15 per cent. of the freight cars in the country were fitted with automatic couplers, and only about 10 per cent. with train-brakes. Only a small proportion of the railroads favored national legislation.

Colonel Haines, President of the American Railroad Association, stated that the hook coupler or the M. C. B. standard had been adopted by that Association, and was being introduced as fast as possible. Representatives of the Master Car Builders' and Master Mechanics' Association spoke in favor of the adoption of the M. C. B. standard, and thought that the general use of automatic couplers would lessen the dangers to trainmen. Representatives of the Switchmen's Mutual Aid Association, however, made some strong addresses in favor of the old link-and-pin type of coupler, and stated that so far the introduction of automatic couplers had very much increased the danger of accident, owing to the difficulty of coupling between the automatic and the old style drawheads. This opinion was endorsed by some of the railroad officers present.

The session was continued into the second day. The Committee has not announced its intention, but it is understood that the members will feel bound to prepare a bill for submission to Congress regulating the subject.

American Society of Mechanical Engineers.—The annual meeting began in New York, November 16. The first session was held in the evening of that day, and was chiefly occupied by the annual address of the President, Mr. Robert W. Hunt, who chose for his subject the American Rolling Mill, making a very interesting paper.

On Tuesday morning a business session was held when the report of the counsel was read, showing the Society to have received $19,843 during the year, the balance remaining in the hands of the Treasurer being only $2. The report made a detailed statement in relation to the house in NewYork. Reports were also received from the Committee on Standards, and the Committee on Standard Methods of Tests, and the Committee on Standard Pipe Flanges.

It was resolved to raise the initiation fee to $25 and the dues to $15 per year. The tellers announced that the ballots had been canvassed, and the following officers were elected: President, Charles H. Loring, Brooklyn, N. Y. Vice-Presidents, G. I. Alden, Worcester, Mass.; E. F. C. Davis, Richmond, Va.; Irving M. Scott, San Francisco, Cal. Treasurer, William H. Wiley, New York. Managers, James M. Dodge, Philadelphia, Pa.; Robert Forsyth, Chicago, Ill.; Jesse M. Smith, Detroit, Mich.

It was also announced that a large majority had voted in favor of holding the spring meeting in San Francisco. The afternoon was devoted to excursions to various points of interest, and in the evening a session was held, at which several papers were read and some of the topical questions propounded were discussed.

On Wednesday no sessions were held, the day being given up to visits to the Brooklyn Navy Yard and other points of interest, the evening being spent by part of the members at the Star Theatre and the remainder at the American Institute Fair.

On Thursday a morning session was held, at which several papers were read and topical questions discussed. The afternoon was left open for excursions to various points, and in the evening a public reception was held at the Lenox Lyceum, at which a large number of members and guests were present.

The concluding session for the reading of papers and discussions was held on Friday morning, November 20, and the convention then adjourned.

American Association of Irrigation Engineers.—This association was formed at the recent irrigation convention in Salt Lake, Utah, and will have its headquarters in that city for the present.

The officers chosen are: President, A. D. Foote, Boise City, Idaho. Vice-President, G. G. Anderson, Denver, Col. Secretary and Treasurer, C. L. Stevenson, Salt Lake City, Utah. Directors, L. G. Carpenter, Fort Collins, Col.; J. B. Greene, Denver, Col.; H. I. Willey, San Francisco.

Train Dispatchers' Association.—The officers of this Association are: President, R. B. Woolsey, Terre Haute, Ind.; Vice-President, H. A. Mace, Dunmore, Pa.; Secretary and Treasurer, C. E. Case, Toledo, O.; Executive Committee, M. C. Coyle, J. F. Mackie, R. S. Quigley and W. W. Olcott; Committee on Train Rules and Orders, J. S. Mackie, W. H. Graves, J. H. McEwen, J. A. Weldon and W. M. Eggleston.

New England Railroad Club.—At the regular meeting, November 10, a by-law was adopted providing that, beginning with January, regular meetings shall be held once in two months instead of monthly.

The subject for discussion was Care of Steam-Heated Cars at Terminal Points, upon which Messrs. Lauder, Marden and Adams were the principal speakers. The general method adopted is to heat cars at terminal points from stationary boilers either erected for the purpose or used for other purposes. This, it was stated, becomes a considerable tax upon railroads having many branches and terminal points like most of the larger New England roads.

A short debate on the subject of Joint Inspection of Freight Cars followed, the general opinion being apparently against the general inspection.

Engineers' Club of Philadelphia.—At the regular meeting, October 17, the following members were elected: J. F. Stevens, Carl G. Barth, Edward G. Bennett, George H. Perkins, A. G. Menocal, B. S. Lyman, and F. M. Smith.

Resolutions were adopted for the appointment of a Committee of three to bring the subject of Land-locked Navigation between the Delaware River and Florida before the commercial bodies of the various seaboard cities. The Committee consists of Captain S. C. McCorkle, Foster Crowell and Rudolph Hering.

Hon. B. E. Fernow, Chief of the Forestry Division in the Department of Agriculture, described the tests of timber now being made by the Department. The matter was discussed, and the Secretary was directed to forward a letter to the Department expressing the Club's appreciation of the importance of these tests.

Mr. F. H. Lewis presented a paper on Soft Steel in Bridges. The use of soft steel, on at least an equal footing with wrought iron and medium steel, was advocated, and numerous tests of the material, in support of the position taken by the author, were presented.

The subject was discussed by letter by Mr. C. S. Sims, Jr., and Mr. Charles S. Churchill, and verbally by Messrs. Henry B. Seaman, E. E. R. Tratman and James Christie.

At the regular meeting, November 7, Mr. Max Livingston read a paper on Solid, Liquid and Gaseous Fuel, referring to their relative values. This was discussed at some length, members bringing up several cases of the use of oil and other liquid fuels.

A paper by Mr. W. W. Thayer on Street Paving was read. This was discussed at considerable length by members present, and in addition some written discussions were read. Some of the criticisms stated a fact which is apparent in almost all cities, and that is, that the trouble is not so much with the kind of pavement used as with the poor foundations, the general habit in this country being apparently to consider that good pavements will do on any kind of foundation. Many interesting facts were brought out in the discussion. One member stated that with the old cobble-stone pavement formerly used in Philadelphia, 1,500 lbs. was considered a load for one horse, while to-day it is very common to take 8,000 lbs. with a pair of horses. The subject was not completed, but was continued until the next meeting.

Civil Engineers' Club of Cleveland.—At the regular meeting, November 10, reports were received on new quarters for the Club, and also on the recent visit to the works of the Walker Manufacturing Company.

Mr. John Walker gave a description of some of the large pieces of work now building for cable railroads, and also for the construction of the melting furnaces in their foundry, which had been very successful.

Mr. E. P. Roberts read a paper on the Incandescent Electric Lamp from the standpoint of the manager and customer. The paper was accompanied by charts showing the light of the lamp with different currents. This paper was briefly discussed.

Professor C. S. Howe read a paper on a New Method of Computing Areas in Land Surveying, which he claimed was shorter than those in general use. This also was discussed.

The tellers reported that J. F. Holloway had been elected an honorary member, and William H. Starr, Albert W. Johnston and J. C. Beardsley active members.

Engineers' Club of Cincinnati.—At the September meeting of the Club Mr. A. O. Elzner read a paper under the head of Engineer and Architect. He called attention to the intimate relations between the professions and the difficulty sometimes to know where to draw the line, and noted in this connection that many of the magnificent ancient works of so-called architecture certainly combined in their construction the ability of both the engineer and the architect. The professions must evidently depend upon each other for assistance in the carrying out of many of the large works of the present time, else an architect must be an engineer or an engineer combine the qualifications of the architect. This is illustrated in the fact that the Board of Architects of the World's Fair Buildings at Chicago simply design and determine exteriors for the various buildings, while the work of preparing detailed plans, specifications, the necessary calculations, and the construction are all in the hands of a separate Engineer Department. Many of the improvements and much of the economy in the construction of the present day are due to the assistance of each profession to the other. Incidental to the paper was a reference to and general description of the construction of the tall modern buildings of iron or steel framing encased in brick or terra cotta. Mr. Elzner exhibited the plans of the Neave Building, in Cleveland, which is of such construction.

Southern Society of Civil Engineers.—At the October meeting, held in Savannah, Ga., a paper on Railroad Location was read by M. H. Lynch, of Fort Worth, Tex., and discussed by members present.

The annual meeting will be held in Jacksonville, Fla., January 18, 1892.

Southern & Southwestern Railroad Club.—The regular meeting was held in Atlanta, Ga., November 19. The first subject for discussion was Uniformity in Locomotive Performance Sheets, including methods of collecting and computing data. This was opened by Mr. James Meehan and was continued by a number of members.

The second subject was Repair Work on Large Systems—whether it was most economical to concentrate the work as much as possible in one large shop, or to conduct it in several shops distributed over the line. This subject was opened by a paper read by Mr. W. H. Thomas, of the East Tennessee, Virginia & Georgia.

Western Railroad Club.—Mr. Waldo H. Marshall has been chosen Secretary in place of Mr. W. D. Crosman, who has resigned. Mr. Marshall was until recently Secretary of the Southern & Southwestern Railway Club.

NOTES AND NEWS.

Military Ballooning.—The Paris correspondent of *Nature* writes: "The new ballooning plant for the use of the French Army arrived recently at Arras from the works of Chalais-Meudon, and differs principally from the old apparatus by the exclusive employment of hydrogen gas compressed to 200 atmospheres in steel cylinders, for inflating the balloon. As such cylinders only weigh 6 kilos to each cubic meter of gas,

the aerostatic plant is considerably lightened, since the preparation of the gas on the spot would have necessitated the transport of 9 kilos of chemical meterials for each cubic meter of gas produced, without taking carriages and receivers into consideration. Another advantage which the new system possesses consists in the extraordinary short time—15 minutes—required for inflating the balloon. Moreover, water can in this case be dispensed with, while with the old system it was necessary to have a supply constantly on the spot. The whole operation of inflating the balloon is rendered extremely simple, and no preliminary operations are required. The balloon can therefore be, so to say, most rapidly mobilized, and thus every tactical opportunity can be utilized, since the balloon can be got ready at any moment and in any place. Eight carriages have been constructed at Chalais-Meudon, each of which is capable of conveying eight cylinders, which are provided with a brass closing valve, constructed by Major Renard. Two carriages fully laden with cylinders are required for the inflation of the balloon. To compress the gas a pump is employed, which can compress 150 cubic meters of hydrogen under a pressure of 200 atmospheres in one hour. It has been stated that the gas used for inflating the balloon can be recovered and again compressed in the cylinders, but this is incorrect, for the compression of the gas requires considerable time, as well as very powerful and ponderous stationary machinery, which could not accompany the Army during a campaign. An aerostatic park is to be attached to each army corps and placed under the direct authority of the head of the general staff, and one to each fortified place designated by the Minister of War. The ascents hitherto made have sufficiently proved the excellent material and construction of the balloons, which may perhaps be destined to neutralize to some extent the advantages claimed for smokeless powder, since they can be so rapidly utilized and enable the occupants of the car to discover the position of the enemy at a great distance."

Electric Lighting by Water Power.—At St. Brieux, Cotés du Nord, France, two 1,300-light Thomson-Houston alternators are driven by two Hercules turbines of the vertical type, one of 125 H.P. and the other of 150 H.P. An interesting characteristic of this plant is that the two alternators are run in multiple upon the same circuits. The distance from the central station to the center of distribution is 8.4 miles, and the pressure employed is 2,000 volts. It is interesting to note that the wire employed to convey the current for 2,600 sixteen-candle-power incandescent lamps 8.4 miles is in this case only 0.31 in. in diameter.

At Guatemala, Central America, a combined arc and incandescent plant has been operated by means of water power since 1887. A part of the plant, consisting of two 1,300-light alternators, is 3¾ miles distant from the city. The dynamos are driven by a countershaft from a 21-in. Rodney-Hunt turbine of 250 H.P. The remainder of the plant, comprising seven 45-light 2,000 C.P. arc dynamos and three 18-light arc dynamos, is 7½ miles away from the city, and receives its power from a 15-in. double Rodney-Hunt turbine of 260 H.P.

The city of Puebla, Mexico, possesses an electric lighting plant which is in many ways remarkable. Two hundred arc lamps of 1,200 C.P. are run by four 50-light arc dynamos in a station about 13 miles from the center of the town, where the River Atoyac furnishes power for a 200 H.P. Leffel double turbine. Each of the four circuits is about 26 miles in length, and consists of a No. 4 insulated wire. The dam and all the masonry connected with the station itself are built of fine cut stone, forming probably one of the most substantial and best built structures in Mexico. As the station is so far from the town and in the midst of a country infested with bandits, the Government finds it necessary to maintain at all times a guard, consisting of seven soldiers, to protect the station from injury by marauders.

A contract recently entered into by the Thomson-Houston International Company provides for a plant to be worked by water power in the town of Piracicaba, San Paolo, Brazil. The system will probably comprise 50 arc lamps of 1,200 C.P. each, and about 2,000 incandescent lamps of the alternating system. In this plant the power will be situated quite close to the lighted district, about one mile away.—*Electrical Engineer.*

Industrial Accidents.—The International Congress which met at Berne, in Switzerland, in October, to consider the question of Industrial Accidents—that is, the accidents to which the workingman is exposed in, and in consequence of, his work—adopted the following resolutions:

"*Prevention of and Payment for Accidents.*—It is an imperative duty to prevent by all possible means industrial accidents and sicknesses resulting from work, and to pay for those which do occur. 1. As to preventive measures it is desirable to combine individual action, that of associations and of the State. 2. As to payment of damages or benefits, the best plan is some form of insurance association, to be organized in each country, the details to be arranged to meet local requirements. 3. In such associations it would seem best to separate accidents slight in their nature, and to carry them by means of the ordinary benefit associations. 4. Where it is considered desirable to establish some form of insurance—pension or annuity—for old age or permanent disability, it might be combined with the insurance against serious accidents and professional maladies.

"*Statistics.*—The Congress, being convinced of the value of statistics when properly collected and classified so as to admit of comparison, requests that efforts be made in all countries to collect statistics of industrial accidents and diseases in a systematic way, and with as much detail as possible. The Executive Committee is instructed to prepare forms for the collection of international statistics, and to submit the same to the next meeting of the Congress. The Committee is advised to consult with the International Statistical Institute, the Committee of the International Congress of Hygiene and Demography and other allied bodies, in order to secure a proper understanding as to the basis of these statistics, such as the proper nomenclature for different professions, causes of death and disease, and similar matters."

A Steam Jet Ventilator.—The production of an induced current by a steam jet for ventilating purposes has been studied by Mr. Granger, who has designed the jet shown in the annexed

FIG. 1.

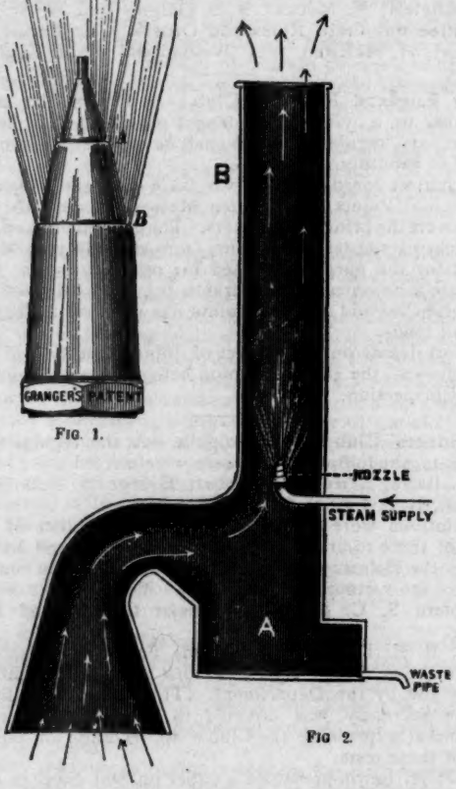
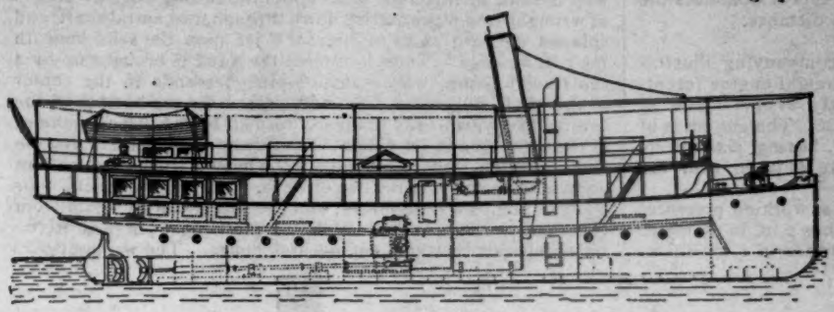


FIG 2.

illustrations, and has applied it in practice for the extraction of foul air and the supply of fresh, the latter result following as a consequence of the former. Fig. 1 shows the nozzle, in which there are two annular orifices, *A* and *B* (adjustable in area) for the issue of steam, the smaller jet supplementing the hollow portion of the larger, so that the two combined form practically a solid jet, but consume very much less steam than any solid jet. Fig. 2 shows the general method of producing air currents. *B* is a shaft containing a nozzle, which latter, when supplied with low-pressure steam, induces a strong air current through *B* in the direction of the arrows. Thus, if the total outlet areas of the nozzle be adjusted to one-sixth of a square inch, it is stated that the air current through *B* will be no less than from 70,000 to 80,000 cub. ft. per hour, or say sufficient to ventilate a room containing 50 persons, allowing the very ample volume of 25 cub. ft. per minute for each person. The small pit or chamber *A* collects any water arising from condensed steam or rain, and which ultimately escapes by the waste pipe. A special feature of the system is the employment of low-pressure steam, which experiments have shown to be a great economic advantage.—*Iron.*

A Triple-Screw River Boat.—The accompanying sketches show a triple-screw river boat, designed for work on shallow streams in India, by Mr. Hugh Dunsmuir, of Govan, Scotland. The boat is 90 ft. long, 20 ft. beam and 11 ft. 6 in. deep; she draws 32½ in. with coal and passengers only, and 38½ in. with a deck load of freight.



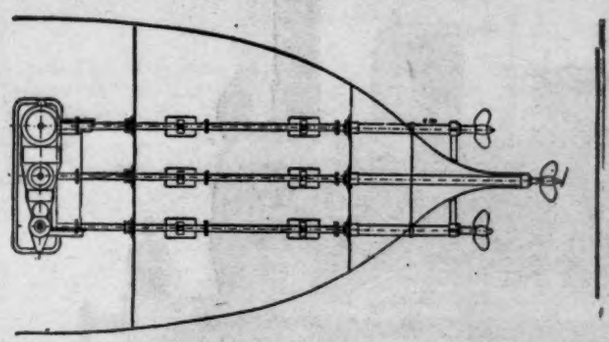


Fig. 1 shows a side elevation of the boat, and fig. 2 a plan of the stern, with the arrangement of screws. All three shafts are driven by one triple-expansion engine with cylinders 9 in., 14½ in., and 27¼ in. in diameter and 10-in. stroke; in ordinary service this will run about 300 revolutions. The engine is so arranged that one cylinder acts on each screw, the three cranks being coupled by a rod in such a way as to counterbalance the large cylinder. This arrangement is fully described in the JOURNAL for May last, page 232.

The screws are three-bladed, 31 in. in diameter and 47 in. pitch. Steam is furnished by a tubular boiler 9 ft. in diameter and 9 ft. long, with two corrugated fire-boxes. The boat has made a speed of 11 miles an hour.

Uniform International Time.—The International Geographical Congress, held at Berne last August, adopted a memorial in favor of an international time system similar to that by which railroad time is now regulated and changes made in the United States and Canada. This system, which has been much discussed in Europe, was generally approved in the Congress, in which 43 nations were represented.

The Congress recommended that a conference be called, to be held in Berne, in which the different nations should be represented by accredited delegates; the Conference to be empowered to adopt a primary meridian as a starting-point and to adjust the details of the system, the meridians of change of hour, etc. The uniform time system will then be adopted by railroads and vessels throughout the civilized world.

The Most Northern Railroad in America.—The line now extending furthest north in North America is the Calgary & Edmonton Railroad, completed in August last, which carries travelers from the Canadian Pacific Railroad at Calgary to Edmonton on the North Fork of the Saskatchewan, in latitude 53° 30′. This is the top notch of railroading on this continent, 800 miles north of New York, and at least 300 miles higher up in the world than the line of railroad now building across Newfoundland. In Europe there are railroads further north, and in Sweden there is a little railroad which crosses the Arctic Circle.

This new railroad in Canada will play a large part in the fortunes of the northwestern country, for in many respects the North Saskatchewan Valley is inviting and abounds in resources, and before a great while there will be quite a large population there. The Saskatchewan will be bridged and the railroad extended at least 50 miles beyond Edmonton. The town of Edmonton is 2,200 ft. above the sea, and though it is so far north, crops are as fine in that region as in most parts of the continent.

With the aid of this railroad it is now possible to travel by steam all the way from the City of Mexico to the shores of the Arctic Ocean at the mouth of the Mackenzie River, except for short portages from the Saskatchewan to the Athabasca River, and around two series of rapids in that river and the Mackenzie. The Hudson Bay Company's steamer runs for many hundreds of miles on the middle and lower Mackenzie River.—*Goldthwaite's Geographical Magazine.*

An Improved Wall Engine.—The cut given herewith shows a strong and handy form of wall engine made by the firm of Ransomes Sons & Jeffries, of Ipswich, England. The uses of this class of engine are well known.

The engine being fixed to the end-wall of the building, the crank-shaft occupies a position at right angles to the face of the wall, and any stress due to the vibration of the engine is transmitted to the wall in a direction parallel with its length, in the direction in which the wall is best suited to withstand such stress. These engines, therefore, obtain a distinct advantage over the usual form of wall engine, which is bolted to one of the side walls of the building, in which latter type the crank-shaft being parallel to the face of the wall, the stress is transmitted to the wall in a direction at right angles to its length. Where the speed of the shop shafting does not correspond to the speed of the engine, the latter may conveniently be arranged to drive the shafting by belt.

The engine frame, with the guide-bars, is in a piece with one of the plummer blocks, and is bolted to a casting which forms the outer plummer block, and which in some cases is brought up so as to form a box above the crank-shaft, thus supporting the wall over the engine. The center casting, at its further extremity, is rigidly secured to a large wall plate arranged on the opposite side of the wall to the engine cylinder; the bolts securing the engine to the wall passing through this plate, any possibility of either plummer-block springing is thus avoided. These engines are sometimes made with a double crank, so that the power can be taken off from both ends of the crank-

shaft. Each engine is fitted with a sensitive governor, acting direct upon an equilibrium piston-valve, and efficient means of lubrication are provided.—*Invention, London.*

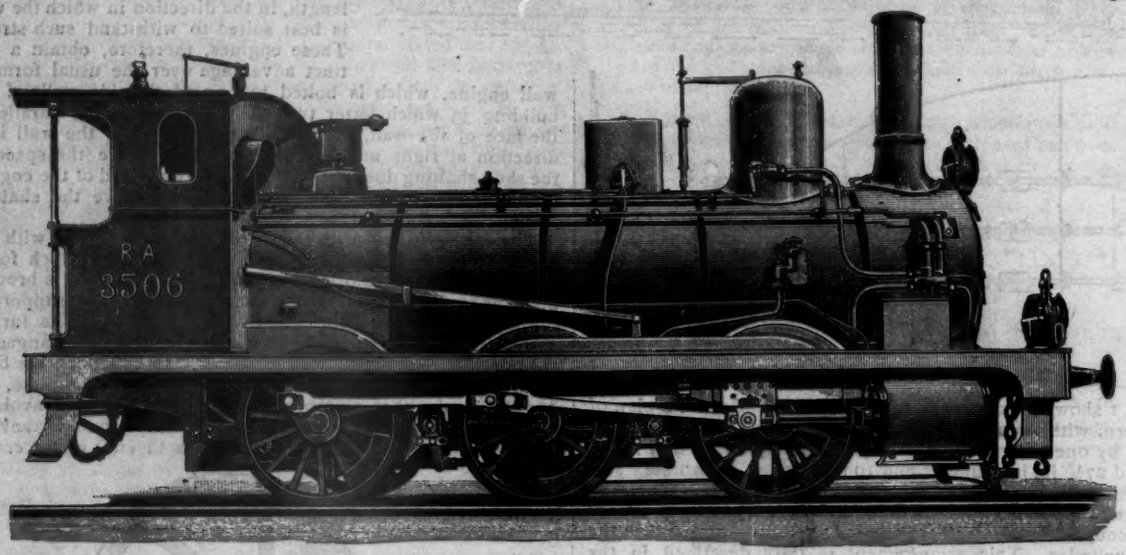
The Fastest Train.—The new train of the New York Central & Hudson River Railroad, which, it is claimed, is the fastest regular train ever run, leaves New York at 9 A.M. and makes the run to Buffalo in 8 hours 41 minutes; an average

speed of 50.6 miles an hour, without allowing for stops. The train stops at Albany, Utica, Syracuse and Rochester, and deducting the time required for these stops, the actual running is done at the rate of 52 miles an hour.

Somewhat better average time is made by some of the trains between Baltimore and Washington; but this is doubtless the best regular time ever made over so long a distance.

An Italian Freight Engine.—The accompanying illustration, from the London *Engineer*, shows a freight engine recently built for the Adriatic Railroad in Italy by the shops of G. Ansaldo & Company, at Sampierdarena. The engine is of a type very commonly used in Europe, having six wheels coupled and no truck. The cylinders are outside, with the steam-chests inside.

The boiler, which is built to carry 150 lbs. working pressure, is 54 in. diameter of barrel, and has 185 tubes 2 in. in diameter and 13 ft. 8 in. long; the total heating surface is 1,170 sq. ft.



The cylinders are 17.75 in. in diameter and 25.6 in. stroke; the driving-wheels are 54 in. in diameter.

The total weight ready for service is 92,500 lbs. The tender weighs 58,000 lbs. full; the tank carries 2,400 galls. of water. The engine is somewhat unsightly to us, owing chiefly to the number of pipes and fittings carried outside the boiler.

Use of Water under Pressure in Founding Dock Walls.—In the execution of the new harbor works at Calais, France, the foundations of the quay-walls for the outer harbor have been sunk by means of water injected under pressure, a method which has been attended with the most satisfactory results as regards economy and rapidity of execution, and which M. Bailly, who describes it in a paper recently presented before the Société des Ingenieurs Civils at Paris, believes to have been there introduced for the first time.

The quay-walls are founded in a very fine and movable sand, easily loosened by water; and, after some preliminary trials, which proved that piles could easily be sunk by a jet of water directed beneath them, the experiment was extended to the sinking of great blocks of masonry built upon a timber curb. The experience gained in these further trials was so far reassuring that the system was then adopted on a large scale for the sinking of the quay foundations and also for the driving of piles and sheeting.

The foundations are carried down to a depth of 8 to 11 meters below the present bottom of the basin, provision being made for the subsequent dredging of the outer harbor to allow vessels of the deepest draft to lie alongside at low water.

The quay is founded upon a series of square wells built of rubble masonry upon a curb or base of strong concrete. The outer surfaces of these square cells are vertical throughout, while the central shaft is octagonal in form and splayed outward at the base, so that the walls come to a sort of cutting-edge, which, however, has a width of 1 meter, corresponding with the width of the concrete shoe. In general, the wells are 8 × 8 m. in outside dimensions, the octagonal shaft being 4 m. in diameter, and the wells are sunk side by side in the line of the quay wall, leaving spaces of 0.4 m. between them. In sinking the series of wells, the first, third, fifth, etc., are first got down, and then the intervening ones, and lastly the intervening spaces of 0.4 m. are excavated by the water-jet and filled with concrete, which dovetails the whole series together by filling two pairs of grooves, which had been formed in the sides of the contiguous masonry wells.

The process of sinking one of these wells is as follows: The masonry cell is first built *in situ* to a height of 4 m., and the well is sunk by injecting water under the cutting-edge by means of wrought-iron pipes carried down through the central shaft, and splayed outward so as to direct the jet upon the sand beneath the cutting-edge. Thus loosened, the sand is brought up by a centrifugal pump, whose suction-pipe descends in the center of the shaft, and draws sand and water from the bottom of the conical cavity, which is gradually formed by the disengagement of the sand around its sides. The pumping-machinery for the sinking of the wells is mounted on wheeled trucks, which run upon a line parallel to the line of wells. For the water-jets, four Tangye pumps are employed, and are supplied with steam from two small vertical boilers, while the centrifugal pump is drive by a separate portable engine and boiler. The wrought-iro pipes, by which the water-jets are delivered, are 12 in number, and are divided into four groups, the three pipes of each group being connected with one of the Tangye pumps by flexible rubber tubes. The jets are so directed around the cutting-edge as to excavate the sand regularly and to correct any tendency of the well to deviate from the vertical in sinking, and in general the deviations are almost insensible.

Some difficulty was at first experienced in the working of the centrifugal pump, owing to the settlement of the sand in suspension in the suction-pipe, which tended to choke the valve at the foot of the pipe whenever the pumping was temporarily stopped. This was remedied, however, by attaching to the valve-box one of the wrought-iron pipes through which a jet of water was at such times delivered into the valve-box just above the valve, and by means of the circulation of a continuous stream of water the deposit of the sand was prevented.

On the average the sinking of a well to a depth of 4 to 4½ m. was accomplished in 12 to 14 hours, which is equivalent to about 20 cubic m. of excavation per hour.

When the well had been sunk to a depth of 4 m., bringing its top to the level of the ground, the masonry was carried up for a further height of 4 m., and the operation of sinking was then resumed.

In a bed of clay the operation is more difficult and much more tedious; but the system was successfully employed to sink through beds of about 1 m. in thickness. It was also applied to the sinking of wells of smaller dimensions, 4½ × 4½ m. and 4 × 4 m. In these cases the rate of sinking in sand was much faster, and it became more difficult to prevent the well from deviating from its true position.

Electric Lighting of Trains.—One of the trains used in the fast express service between Frankfort and Berlin is now lighted by electricity. Each carriage has two storage batteries, and the lights are on two distinct circuits, so that if one of the batteries should fail or be removed for renewal, one-half the lights will remain. The storage batteries have a capacity of 200 ampère-hours each, and are specially constructed so as not to be disarranged by the uneven motion of the cars. Each battery runs four 8-candle-power lamps in the compartments and one 5-candle lamp in the saloon. The batteries weigh about 660 lbs. each.